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Water Quality

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ENVIRONMENT VIEWS

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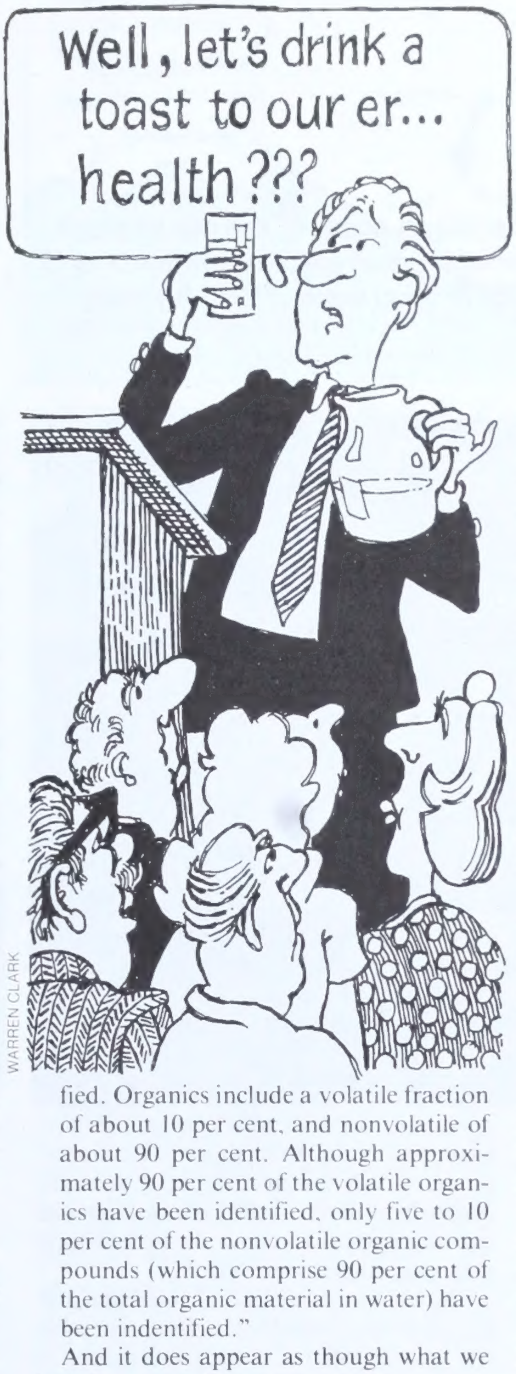
Cover photo: Susan Brun

EDITOR'S NOTEBOOK


Well, let's drink a toast to our er... health ???

WARREN CLARK

"*Canada? It's a nice place to visit, but you can't drink the water.*"

That seems a highly unlikely scenario. After all, Canada has always been a land of wide open spaces, of shimmering lakes and sparkling streams. But what is it like below all those shimmering surfaces? Could the day come when we could no longer count on the universal good quality of the water from our city taps or mountain streams?

In this issue of Environment Views, we take a close look at water quality: what goes into our surface waters and what its impact is; how water supplies and wastewater are handled; and how safe the water is for us and for all the other species which rely on it.

By all reports, Alberta's water quality is as good as or better than, almost anywhere in the world. Few of our lakes and rivers are crystal clear (a fact which drives displaced British Columbians like me crazy, as I search in vain for a handy place to swim where you can see your knees and the weeds don't tug at the ankles). But our drinking water is at least clear of most of the exotic contaminants which make up the chemical soup of the Great Lakes.

In a recent issue of the consumer magazine *Homemaker's*, the authors painted a truly horrifying picture of the quality of water in the Great Lakes system: of 89 compounds identified in the water and evaluated, 18 are known to be acutely toxic; 33 are known to cause chronic ill-effects in humans; and 38 are known to cause such chronic effects in test animals.

The same study was able to identify a further 292 contaminants without being able to evaluate their toxicity, if any. There simply was not enough toxicological data.

A report prepared for the U.S. National Academy of Sciences by Gerard A. Rohlich of the University of Texas concludes that such gaps in our knowledge are general. For one group of contaminants, organic compounds dissolved in water, Dr. Rohlich observes:

"Only a small fraction of the total organic matter present in water has been indentified. Organics include a volatile fraction of about 10 per cent, and nonvolatile of about 90 per cent. Although approximately 90 per cent of the volatile organics have been identified, only five to 10 per cent of the nonvolatile organic compounds (which comprise 90 per cent of the total organic material in water) have been indentified."

And it does appear as though what we don't know can hurt us.

Although chlorine has been widely used as a disinfectant in municipal water supplies since the early part of the century, it wasn't until 1976 that a researcher uncovered the fact that chlorine combines with naturally-occuring organic materials to form a group of potentially toxic byproducts. Called trihalomethanes, these compounds include chloroform, a carcinogen.

In Alberta, and in much of the rest of the country, the levels of trihalomethanes in the drinking water do not exceed federal standards, and in fact the Canadian Drinking Water Standards for other contaminants are rarely exceeded here.

It is not, however, reassuring to compare the relatively short list of items which are included in the standards against the vast array of industrial and domestic chemicals which have been found in the water.

In discussing the setting of safety standards for chemicals which are newly developed and have not been studied sufficiently to establish their safety, Dr. Rohlich writes, "The potential for existing concentrations of organic pesticides and other organic contaminants in drinking water to adversely affect health cannot be estimated with certainty at this time.

"The risk assessments do not take into account interactions such as additive toxicity, synergisms and antagonism.

"What ultimately may be most important is the interaction of these compounds with each other and with other material in contributing to the total body burden resulting from multiple sources of contaminant exposure."

The picture is not all gloomy. Through great strides in sewage treatment, outbreaks of disease caused by waterborne bacteria have almost been eliminated. The North Saskatchewan River, so loaded with organic material in the 1940s that its store of dissolved oxygen was almost totally depleted, is much cleaner today (see stories page 17 and 33).

For toxic, persistent chemicals which are hard to remove from the water, the only safeguard may be stopping them at the source. (For a discussion of the zero discharge option, see the Viewpoint by Dixon Thompson, page 8).

Many other contaminants may be combated through improvements in industrial technology enabling re-use rather than discarding of industrial byproducts. For others, a more aware society could be the key to improvement. Especially in a province like Alberta, where the level of industrialization is low, much of the harmful products that show up downstream have domestic sources (see story page 27). Don't pitch that solvent down the laundry sink!

Maryhelen Vicars, a former journalist, is the freelance editor of *Environment Views*.

Gillian Sniatynski

Water is Life

"I'm 49 years old. There's probably enough water to see me through. But I have nine grandchildren. Four of them live in Lloydminster and my daughters are giving them bottled water." Don Appleby

ALBERTA GOVERNMENT PHOTO

A beautiful Alberta Environment poster shows a cluster of cattails against a background of blue, sun-flecked water. "Water is life" is the caption.

The caption does not overstate the case. We need to drink water to stay alive. We need it to provide food — as irrigation for crops, and for the life-sustaining plant process of photosynthesis.

We depend on water because it is an inextricable part of our ecosystem, a habitat for untold varieties of plant and animal life. Indeed, the earth receives about 70 per cent of its oxygen as a byproduct of the photosynthetic activity of marine plankton.

As if these most fundamental uses were not enough, water has its strictly practical uses too —washing, transportation and scores more.

And it could be said to sustain our souls as well. Dozens of recreational activities depend on it, and it is, often, a source of great esthetic pleasure.

Oceans and seas make up about 97 per cent of all the water in the world. The rest is found in surface water bodies like lakes and rivers, in glaciers and polar icecaps, in ground water, and in the water vapor in the atmosphere. All the water of the earth circulate endlessly between ocean, atmosphere and land in a pattern known as the hydrological cycle (see diagram on Page 5).

Water is a compound of hydrogen and oxygen atoms, convertible by heat into vapor and by cold into ice. It boils and freezes at known temperatures. But beyond these basic properties, it varies endlessly in all its "natural" states. It is more or less colorless, more or less odorless, more or less transparent, but its character depends on many factors.

Surface and groundwater may absorb chemicals from the soils over (or through) which they pass; rain may pick up (and later deposit) others as it passes through the air. Volumes of water in rivers — and hence the relative concentrations of chemicals in them — vary with the seasons. Volume and speed of flow also affect the amount of sediment in suspension.

If follows, then, that "pure" water is rather hard to define.

Part of what passes into surface water bodies from the surrounding land consists of minerals that encourage aquatic plant growth. As the plants take hold and thrive, all forms of life in the food chain above them also multiply, and a richly diverse ecosystem develops. This process is the means by which the water accommodates its contents. Not only is there a diversity of life forms, but there is also a balance among them.

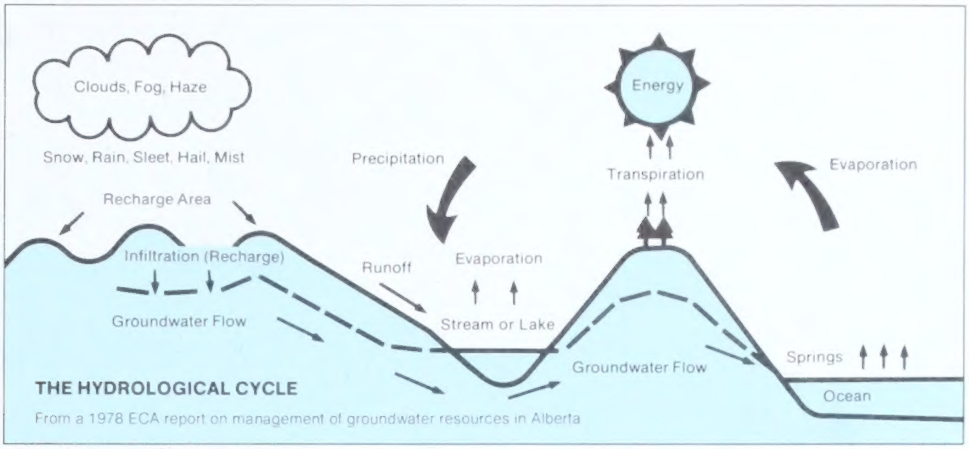
The basic difference between the natural and the polluted state is that the balance of life forms is upset.

Man pollutes surface water by discharging organic and inorganic material (like sewage and industrial effluent) directly into it, and by modifying the surrounding land. Pesticides applied to agricultural land, wastes from mining, or soil exposed to erosion after land-clearing operations can all reach lakes and rivers through run-off.

There are three main effects of this pollution:

1. The water's vital oxygen supply may be depleted. This is because the breakdown of organic matter requires oxygen. Nutrients in organic material may also stimulate plant growth, whose subsequent decomposition aggravates the oxygen supply problem. And the amount of available oxygen is a constraint on the variety of plant and animal life able to exist in the water. This process is called eutrophication.
2. Toxic materials may directly kill off various species, or may be taken up by certain organisms, enter the food chain and accumulate in dangerous quantities in other species. (A recent report from the Alberta Environmental Centre warns of the presence of mercury in four fish species in the North Saskatchewan River.)
3. Heated water which may be discharged from power plants also reduces the amount of available oxygen, stimulates algal growth, and (by creating heat barriers) affects fish movements.

Water pollution may affect humans di-



THE HYDROLOGICAL CYCLE

From a 1978 ECA report on management of groundwater resources in Alberta

Carl Primus

SUSAN BRUN

Jack Glenn

rectly (by adding undesirable chemicals or pathogenic bacteria to our drinking water — or mercury to the fish we may need for food). Or it may work indirectly, by interfering with our recreation, for example.

An Alberta Environment statement of water management principles for the province notes that "the principle that pollution must be controlled at its source is a key component of the government's program." The government's strategy is to be preventive, and "use of a stream as a receiving body for water discharge must never cause any break in the ecological cycles that ensure the self-purification process."

But the statement also makes the point that "the assimilative capacity of receiver streams is, however, recognized," and "the assimilative or self-purification capacity of watercourses must be regarded as a natural resource that is legitimate to use."

Making use of a river's assimilative capacity means capitalizing on natural processes as a means of breaking down and disposing of organic wastes. The crux of the matter is the interpretation of "assimilative capacity." How much organic material *is* the river able to absorb without undergoing damaging long-term change? What trace levels of heavy metals and other hard-to-degrade toxic substances can it contain and still be considered of acceptable quality? Unfortunately, no ready answers exist. And in the vacuum, some strong feelings about water quality have emerged.

Feelings about water (and its management) are strong enough in the province anyway. Though Alberta as a whole is blessed with abundant water, it isn't found where it's most needed. The southern part of the province, with 80 per cent of the population, must manage with 15 per cent of the water. Demands made on that water are diverse and often conflicting; the fact that we require many of our streams to carry off treated sewage and other effluents is one more burden.

The fact is that, when it comes to water management, quality and quantity are two sides of the same coin. If, for example, we want to make substantial withdrawal of river water for irrigation, we have to recognize that the same river can't also be expected to deal with large discharges of effluent —because its capacity to dilute those discharges would be greatly reduced. As in the case of the Bow River around Calgary, we can't expect to use the river as a receiver of large quantities of sewage effluent and still have one of the best trout fisheries in the world.

Water management within the province is the responsibility of Alberta Environment. Recognition is given to the importance of water for human consumption, for food production, for industrial use, and for "other uses" (which includes all in-stream uses) in that order.

How does planning for water management take account of both quality and quantity issues?

Carl Primus, director of Alberta Environment's planning division, cites the department's ban on effluent discharge from many industries. (Most petrochemical industries for example, use deep well disposal methods.) On certain streams, release of effluent from sewage lagoons is allowed only at times of peak flow. And decisions have been made not to allow industry on streams with inadequate capacity to dilute effluent. (A tentative application to locate a large-scale petrochemical plant on the Battle River, for example, was rejected for that reason.)

Beyond merely reacting to user demands, Primus says Alberta Environment's water management planning is being increasingly directed at attempts to better forecast long-term implications of management decisions.

A good example of that sort of planning is the South Saskatchewan river basin study now well under way.

Planner Jack Glenn says data on water quality and use have been collected for the three rivers of the South Saskatchewan system (the Red Deer, the Bow and the Oldman), and a number of different scenarios for water use and management have been drawn up. In all the possible scenarios, irrigation is the most variable factor.

"We are trying to understand what water quality (conditions) might be expected to exist under different conditions of use and management of the water," said Glenn.

Decisions are now awaited on the different options proposed. Action on the decisions might lead to a heavy emphasis on storage, for example, or a thrust towards conservation and improved efficiency in the use of existing supplies.

Someone who fears the storage option is John Eisenhauer, chairman of the Alberta Water Management Coalition. (The coalition, formed in 1981 to help increase Albertans' awareness of the interbasin transfer issue and water management issues generally, numbers among its member organizations like the Alberta Fish and Game Association, the Alberta Wilderness Association, the National and Provincial Parks Association and the Canadian Association of Professional Biologists. Some 30,000 individuals are represented by these groups.)

Mr. Eisenhauer says the coalition is concerned about water quality in all the major drainage basins in the province. He has a personal and specific interest in the southern rivers, especially the Bow.

"The Bow has been on borrowed time for the two decades I have been associated with it," he said.

"We are experiencing major fish kills. There is a well-known weed problem in the river . . ."

Eisenhauer is concerned about any increase in withdrawals from the river for irrigation, and, particularly, about the possibility of a dam (for irrigation) on the lower Bow.

Lakes and Groundwater Vulnerable

SUSAN BRUN

Concern about water quality in Alberta tends to focus on rivers, since for most of us rivers provide the water we need — and carry off the wastes we don't need.

But lakes and groundwater supplies are susceptible to pollution too.

Alberta's lakes are naturally eutrophic. This means their waters are rich in nutrients from the surrounding land, so life forms proliferate. But this proliferation eventually dies, and adds to the accumulation of debris on the lake bottom. The lake grows narrower, shallower and warmer. Finally it returns to marsh, and dry land.

Though this process is natural, it can be accelerated by many human activities.

Badly installed septic systems, clearing of land along the lake shore (allowing run-off to carry sediment and nutrients into the lake), fertilizing of lake-side cottage lawns, allowing livestock on the lake shore or in streams draining to the lake, can all contribute to the problem.

Groundwater pollution can occur when toxic chemicals or other undesirable substances leach or percolate through soil to the water table.

New York State's infamous Love Canal (used for years as a dump for toxic chemical wastes) is an example of the worst consequences of groundwater pollution.

But there are accidents closer to home, too. In 1976, an underground pipe carrying PCBs ruptured at a factory near Regina. Two years later there was public concern about possible contamintaion of the groundwater (used extensively in Regina for domestic purposes) and major clean-up measures were recommended.

Downstream Politics

The problem of balancing conflicting demands is compounded by the fact that many rivers whose headwaters are in Alberta flow from west to east across provincial boundaries. The Prairie Provinces Master Agreement on Apportionment, signed in 1969 by the governments of the three prairie provinces and Canada, permits Alberta to take from rivers that eventually flow into Saskatchewan a quantity of water equal to half the natural flow of water originating in or flowing through the province. A quantity equal to the remaining half must be permitted to pass downstream into Saskatchewan. This agreement is administered by the Prairie Provinces Water Board.

Carl Primus, director of Alberta Environment's planning division, says that the agreement is prescriptive on quantity, but makes little more than passing reference to the need for Alberta to consider water quality as well. The Prairie Provinces Water Board is currently working to make the quality requirements more specific.

"The lower Bow in the city of Calgary is the world's finest dry fly trout stream. In 1977 the river received about 200,000 angler use days — and that's almost all on the main stem of the Bow.

"If a dam is put in we will see drawdowns from the site during the summer of about 15 metres. There will be barren wasteland along the shoreline."

Don Appleby, a member of the Environment Council of Alberta's renewable resources study group, is also concerned about water quality.

"I'm 49 years old. There's probably enough water to see me through," he said. "But I have nine grandchildren. Four of them live in Lloydminster and my daughters are giving them bottled water.

"After 25 years of industrial growth, we have got to the situation where the Bow is reported to be nothing but a mess, and the Oldman, the Red Deer, the Athabasca and the North Saskatchewan are no better.

"The government and the people of Alberta must start taking water quality (seriously) for future generations."

Dr. Steve Hrudey, a professor of civil engineering in the University of Alberta's environmental engineering and science program, challenges those whose complaints about water quality are the loudest.

In the first place, he says, no effluent treatment is 100 per cent efficient — there will *always* be something to dispose of. And if that waste is not to be put into water, then where *is* it to be put? Should deep wells be a universal solution? Do we know enough, for example, about the consequences of deep well failure?

Secondly, he asks, are the people concerned about water quality prepared to put their lifestyles on the line?

"There's more of a health onslaught when they dose their lawns for dandelions or paint the fence," he said.

"You have got to look at these balances and say, the fact that we can identify something in the drinking water is not necessarily significant relative to the amount of alcohol people consume . . .

"A common argument that people will make is that there is no choice with drinking water, and there is some validity to that.

"But we have come such an awfully long way that you can't blame environmental engineers for being a bit happy over the fact that people are no longer dying from typhoid or cholera. Current technology prevents that from happening . . .

"The risks are worthy of study, attention and vigilance — but I have no fear of having my kids drinking the water."

Trefor Reynoldson, head of the surface water section of Alberta Environment's water quality control branch, concurs.

"There seems to be a great popular misconception about water quality," he says. Improved sewage treatment has in fact improved the quality of the province's water in the past ten to 15 years, he feels.

We are fortunate, too, in the fact that we don't yet have much industrial activity — and the industries we do have are modern.

"Compared to other parts of the world," says Mr. Reynoldson, "our quality problems are minor."

For Dr. Dixon Thompson, a professor in the faculty of environmental design at the University of Calgary, that state of affairs is itself a potential problem.

"We have got to be very careful not to be complacent," he says. "The big populations of Edmonton and Calgary have polluted the Bow and the North Saskatchewan with impunity. They have not had to take serious responsibility for what they inflict (on downstream users)."

Given likely increases in population and industrial growth, Dr. Thompson feels that we should aspire to much more stringent restrictions on what we put into our water — even if those restrictions don't seem practical right now.

In a book just published by the Banff Centre School of Management, called "Water Policy for Western Canada: The Issues of The Eighties," Carson Templeton writes:

"The biological, physical and human environments have been given to this generation to administer as stewards. We should touch water resources with thoughtful respect and pass on to future generations a healthy, viable resource. Having a conscience is always a constraint and so it will be in managing water resources."

Gillian Sniatynski, the former editor of this magazine, is an Edmonton freelance writer and editor.

VIEWPOINT

Dixon Thompson

Dixon Thompson is a professor in the faculty of environmental design of the University of Calgary.

Only a few short years ago, any attempt to discuss the concept of zero discharge was greeted with hoots of laughter, howls of outrage, or cries of derision. Recently however, there has been increasing recognition that, for persistent toxic pollutants, zero discharge must become a long term goal.

Under a program of zero discharge, the release of toxic materials to the environment would be prohibited. In many cases the development of technologies and management skills is necessary to achieve zero discharge as a criterion for management of toxic pollutants.

Before making that case, let me define a couple of terms and explain some facts. Persistent pollutants are those which are not biologically, chemically or physically broken down and rendered harmless in the environment. Examples are toxic heavy metals, radioactive elements, and refractory organic compounds such as PCBs (polychlorinated biphenyls) and persistent (non-biodegradable) pesticides.

The federal government's Canada Water Year Book 1981-1982 defines a toxic substance as "... one which may cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological or reproductive malfunctions or physical deformities in any organism or its offspring, or which can become poisonous after concentration either in the food chain or in combination with other substances."

It is very important to note that because these materials do not decompose or decay in the environment, they accumulate. They also tend to be concentrated through food chains. Frequently they can combine to produce an additive effect, or they can multiply each other's toxicity in a synergistic fashion. However, as yet we do not test pollutants for their effects when combined.

Finally, we must note that as populations and levels of industrialization increase, each individual, or each industrial activity must continually reduce the amount of pollution it releases if the total assault on the environment is to remain the same.

UNIVERSITY OF CALGARY

The case for zero discharge is being strengthened. Small concentrations of persistent toxic materials are more frequently being found in the environment, and in human tissue. This is in part due to large improvements in our ability to measure very small quantities of these materials. On the other hand, some of the organic compounds have only been manufactured for a few decades at most and so the fact that these materials can already be found in humans is cause for concern.

Rachel Carson, in her benchmark book *Silent Spring,* made the case 20 years ago against one group, the persistent pesticides, especially DDT, due to their effect on the reproduction of birds.

The Ontario government's expensive program to identify which size of which species of fish from which lakes are edible, illustrates the high cost of permitting even low levels of pollution to occur.

In eastern Canada, local, provincial and federal governments are considering the use of activated carbon treatment for water supplies in an effort to reduce the level of toxic materials in communities' drinking water.

Much of the issue revolves around what is accepted as a safe level for any pollutant. At present, safe levels are often determined by testing animals and then extending those results to humans. Test results are not always dependable. In fact, the test results of the American company Industrial Biotest Laboratories were falsified for a large number of pesticides now in use in Canada. In the case of the drug thalidomide, animal tests did not reveal its toxic effects on humans. There are now indications that levels of some pollutants, previously thought to be safe, may not be so even if, at those levels, they show no easily identified health effects.

For example, it has now been shown that there is a correlation between low levels of lead in the blood and learning disabilities, lower IQ, and lower eye-hand coordination. Such effects would not be revealed in any animal tests and cause and effect relationships would be difficult if not impossible to prove in human populations.

These factors are leading to an increasing level of anxiety if not paranoia, in parts of North America where pollution at "safe" levels has been permitted. Politicians are being forced to respond to an increasingly emotional issue.

Economically and practically, an absolute requirement for zero discharge of toxic pollutants is impossible. However, once pollution has been allowed to occur, it is difficult if not impossible to reverse some of the effects. Therefore, we must err on the side of caution and establish zero discharge for toxic pollutants as a long term goal.

Maryhelen Vicars

Drinking Water

How safe is the drinking water in Alberta?

First the good news: Compared to water supplies in much of North America and elsewhere in the industrialized world, it's great. We have the bacteria problem well in hand, except for isolated incidents such as occurred earlier this year near Drumheller, when sewage was blamed for an outbreak of illness.

Alberta has relatively little industrial development, so the volume of toxic chemicals which could invade our water supplies is relatively small. Many of our communities draw water from rivers fairly close to their source in the Rocky Mountains — before they have had a chance to accumulate much in the way of pollution.

Most of our communities have good secondary treatment plants for sewage so that when it is released into the rivers much of the biological wastes are already broken down.

The bad news side of the ledger is a little harder to pin down. While the water treatment and monitoring systems ensure that most of us have drinking water that is free of bacterial contamination, we may not be doing nearly as good a job in controlling the spread of viruses. Even more serious, our water treatment plants do little to eliminate toxic chemicals.

Dr. Ridley Shaw, a research scientist with the federal defence research established at Suffield, says, "Anybody downstream of Calgary and Edmonton has something to worry about. It's an ongoing problem."

Ironically, one group of toxic chemicals rises from water treatment itself. Chlorine, used to kill bacteria, reacts with naturally occurring organic material, such as decayed plant material, to produce a group of chemicals called trihalomethanes (THMs) including chloroform, which can cause cancer.

Over the past 30 years, a vast array of synthetic chemicals has been developed for use in industry and as pesticides. Many are toxic to humans and animals and many find their way into the water we drink. In Alberta, the low level of industrial activity means that most of these toxic chemicals, if they are present at all, are probably found in very low concentrations.

SUSAN BRUN

This should be reassuring, but there is growing concern about the possible impact of long term exposure to even low levels of both the synthetic organic compounds and THMs. What are the safe exposure levels over ten, fifteen or thirty years?

There just don't seem to be conclusive answers to these questions. Most of these synthetic chemicals, of which there are tens of thousands in use in Canada, have been developed since the end of World War II. Of necessity, the testing which has been done was done with test animals given large doses of these compounds for short periods of time.

It is very difficult to predict from these tests the health effects on humans exposed to small amounts of contaminants over many years.

David Spink of Alberta Environment's standards and approvals division explains, however, that making these projections is one method used by the federal-provincial committee which sets Canada's drinking water quality standards.

"There is a lot of guestimating in terms of health risk," he says. "But once you have identified a substance as carcinogenic, mutagenic or genotoxic (causing genetic changes) I think you have to proceed with caution. The committee's general approach is to be conservative. Ideally we don't want any of it in the water, but in terms of technology we may have to live with some."

Dr. Ken Clementi, medical officer of health for the Medicine Hat health unit, says he is concerned about the lack of routine testing for viruses in drinking water.

"Bacteria plays a less important part in disease today. Anyway, when it is discovered, it is readily treated. But the commonness

ROBIN SCHLAHT

Ken Clementi

of bacterial infections has been replaced by the commonness of viral infections." He says not enough is being done to determine how much of this is being transmitted through drinking water.

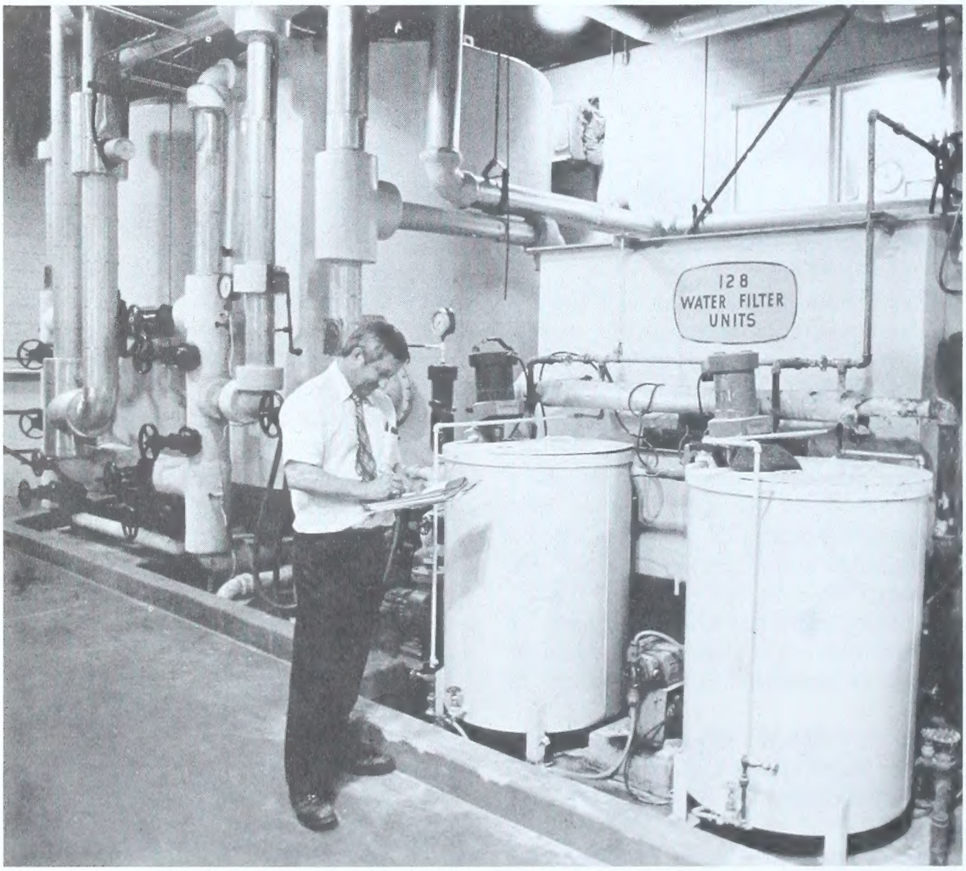
"There is quite a bit of evidence that chlorine doesn't kill all viruses, and some people believe it hardly kills any. In smaller communities, the chlorine is almost certainly not in the water long enough (to be effective against viruses)."

Dr. Clementi points out that some research, although still controversial, has linked exposure to trace contaminants to a weakening of the body's immune system, which in turn could account for the relatively high incidence of virus-caused disease.

"While there is not much interest in Canada in research on the link between trace contaminants and illness, particularly in children, there is a great deal of interest in the U.S."

Dr. Clementi says that sensitivity to trace contaminants can show up as asthma, gastrointestinal upset, marked mood changes and hyperactivity in children, as well as a decrease in the effectiveness of the immune system.

Water purification equipment at the Labatt's plant (below).



BILL McKEOWN

SUSAN BRUN

Peter Huck

"The public has a right to know that what it is drinking is not pure water, by a long shot."

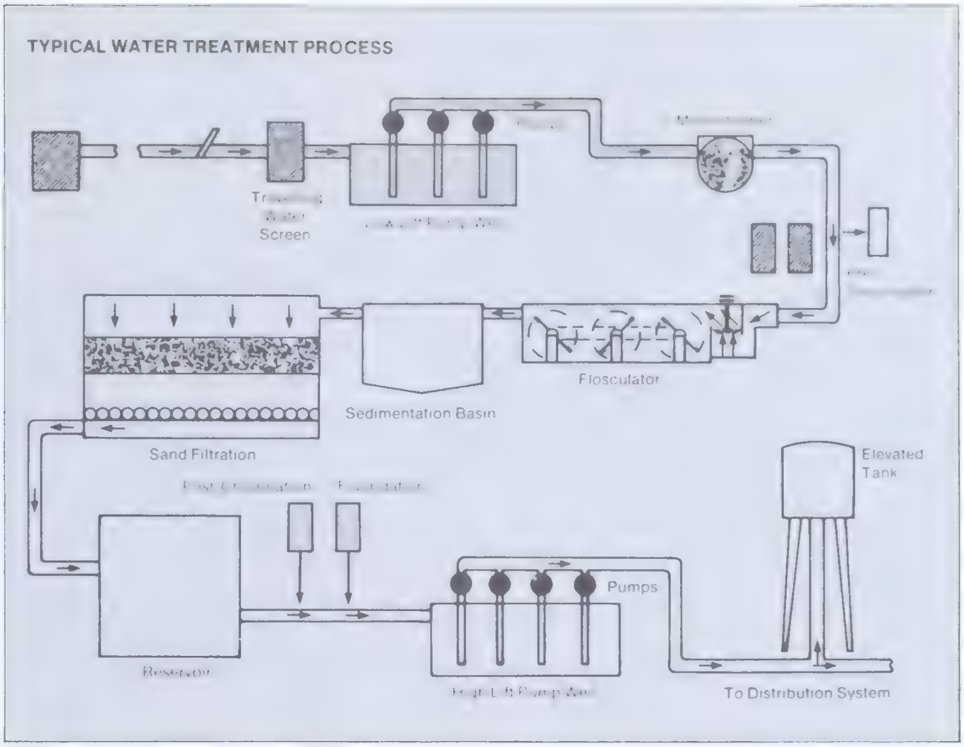
Peter Huck is an associate professor of civil engineering at the University of Alberta who is involved in research on water treatment systems. He feels that in light of the difficulty of identifying and testing the range of synthetic compounds which could be either carcinogenic or mutagenic, it is "prudent for us to attempt to minimize the levels of organics in drinking water.

"In general, the synthetics are of concern in themselves, but the humics (naturally occurring residues from decaying plant matter) are of concern, although they are innocuous in themselves, because they combine with chlorine to produce chlorinated organics, including trihalomethanes.

"It's a tricky job just to identify the products that might be formed in reaction with humics. As well as the trihalomethanes there are also a great many others in lower concentrations, which have not been tested for carcinogenicity or mutagenicity.

"The big unanswered question is: What effect will these have on people exposed over a lifetime?"

Water treatment systems in use in the province basically filter and disinfect the water, using chlorine. Reid Seidner of the Calgary water works department says the Calgary system has been basically unchanged for 30 years and is still adequate, despite some recent concern about organics. Levels of THMs are particularly low in the Calgary supply, he says, because the water being treated is fairly clean; there is little raw



material for the production of the unwanted reaction products. There is little industrial activity, and limited use of agricultural chemicals within the watershed.

As with many other treatment plants in the province, the Calgary system consists basically of filtration and disinfection. The water is treated with alum to coagulate and settle out solid particles, filtered and disinfected with chlorine.

Chlorine gives a characteristic taste and smell which some find unpleasant, in addition to the concern about its unwanted byproducts. In some areas, (throughout France, for example) ozone (a form of oxygen with three molecules) is used as a purifying agent.

Ozone gives a better taste and odor, destroys bacteria and may do a better job of destroying viruses than chlorine. However, there are some drawbacks, Huck says. While it won't form THMs, it will cause the formation of different but perhaps equally harmful reaction products.

"Basically any disinfectant powerful enough to kill bacteria will react with organics."

Another drawback is that its effect is shortlived. With chlorine disinfection, some of the chlorine remains in the water after treatment. Should there be any accidental contamination of the water after it leaves the plant, the chlorine remains as a safeguard. Also, levels of residual chlorine are periodically tested at points throughout a distribution system. Where there is a sudden drop in chlorine levels, this is a sign that there may be a source of contamination introducing micro-organisms which are "using up" some of the chlorine.

This drawback can be corrected by add-

Edmonton's Rossdale water treatment centre

ing trace amounts of chlorine at the end of a treatment process using ozone.

And finally, a great drawback is cost. Converting to ozone or adding granulated carbon filters to remove toxic chemicals would involve a high capital cost, one that may be difficult to justify with the present limited state of our knowledge of the health effects of these contaminants.

Granulated activated carbon (GAC) filters are used to "scrub" organic compounds from the water, and when properly maintained, can remove almost all toxic substances and chlorine. They are used widely in industrial systems — soft-drink bottling plants, for example — and in home devices.

Huck is involved in a study at Edmonton's Rossdale water treatment plant of strategies for eliminating the taste and odor problems which plague Edmonton water each spring. The cause is believed to be the phenols and hydrocarbons which are accumulated on the snow over winter and released during spring runoff.

Ozone disinfection and GAC filters are to be used in the Rossdale pilot project. In Calgary, also, the water works department is studying the use of ozone at its Glenmore reservoir.

Short of making a costly conversion to a different type of disinfection, Huck says there is another strategy to reduce the amount of organic chemicals in the drinking water: changing the point at which chlorine is added to the water as it makes its way through the water treatment plant.

"Typically the chlorine is added at the beginning of the plant to prevent growth of bacteria and algae within the plant. This also ensures that the chlorine has enough time to react with the bacteria before the water goes out into the system. The problem is that the chlorine is added before there has been time to remove any of the organics."

The coagulation and mixing processes will allow some of the organics, especially humics, to aggregate and settle out. If the water is chlorinated *after* this process is completed, then there are fewer raw materials to form trihalomethanes. The coagulation and mixing processes themselves can be altered so that as well as reducing turbidity, they remove more organics.

The problem with changing the point of disinfection, says Huck, is that it makes the treatment somewhat less effective against bacteria, a "trade-off" of maximum protection from acute illness (caused by bacterial contamination) for better protection from the not-conclusively-proven threat of chronic disease.

Two other chemicals can be used instead of chlorine, neither of which form trihalomethanes as readily: chloramine is not as effective at combating bacteria as chlorine, but it is easier to maintain in residual amounts within the system; chlorine dioxide is a good disinfectant, but it is expensive and has some toxic properties.

"There is no easy answer," says David Spink. "It's not simply a matter of spending more money to make the water perfectly safe."

Some of the same concerns are facing the relatively small percentage of Albertans who are not connected to a municipal water source, who may rely on well water, dugouts or an intake in a nearby lake or river.

Throughout the province, public health inspectors offer a free sampling and testing service to ensure that these diverse water supplies are as safe as possible.

In the case of wells, if a new well is analyzed and found to contain no harmful chemicals, and if it is sealed and sited so that no bacterial contamination occurs, then only softening may be needed to make the water acceptable.

Dugout reservoirs may be more of a problem. Many have sophisticated set-ups with floating intakes, pressure sand filters and a range of conditioning devices, including even fluoridation for good dental health.

But, says Ken Blom of the Barons-Eureka health unit in southern Alberta, "A lot of people just take their drinking water straight from the dugout without even boiling it. I'm amazed at times that we don't have more problems than we do."

Maryhelen Vicars, a former journalist, is the freelance editor of *Environment Views*

Home Remedies

There's a brisk business in home remedies such as bottled water, filters and home distillers as concern mounts over the quality of drinking water.

But for many of these alternatives, it's buyer beware: there's no guarantee that the bottled or home-conditioned water will be any better for you than what's available from the tap. It may just cost more. Some of it, in fact, may be much worse.

Bottled water is only as good as the quality of the source and the handling practices of the bottler. With home water conditioners, following manufacturers' recommendations and doing proper maintenance is essential.

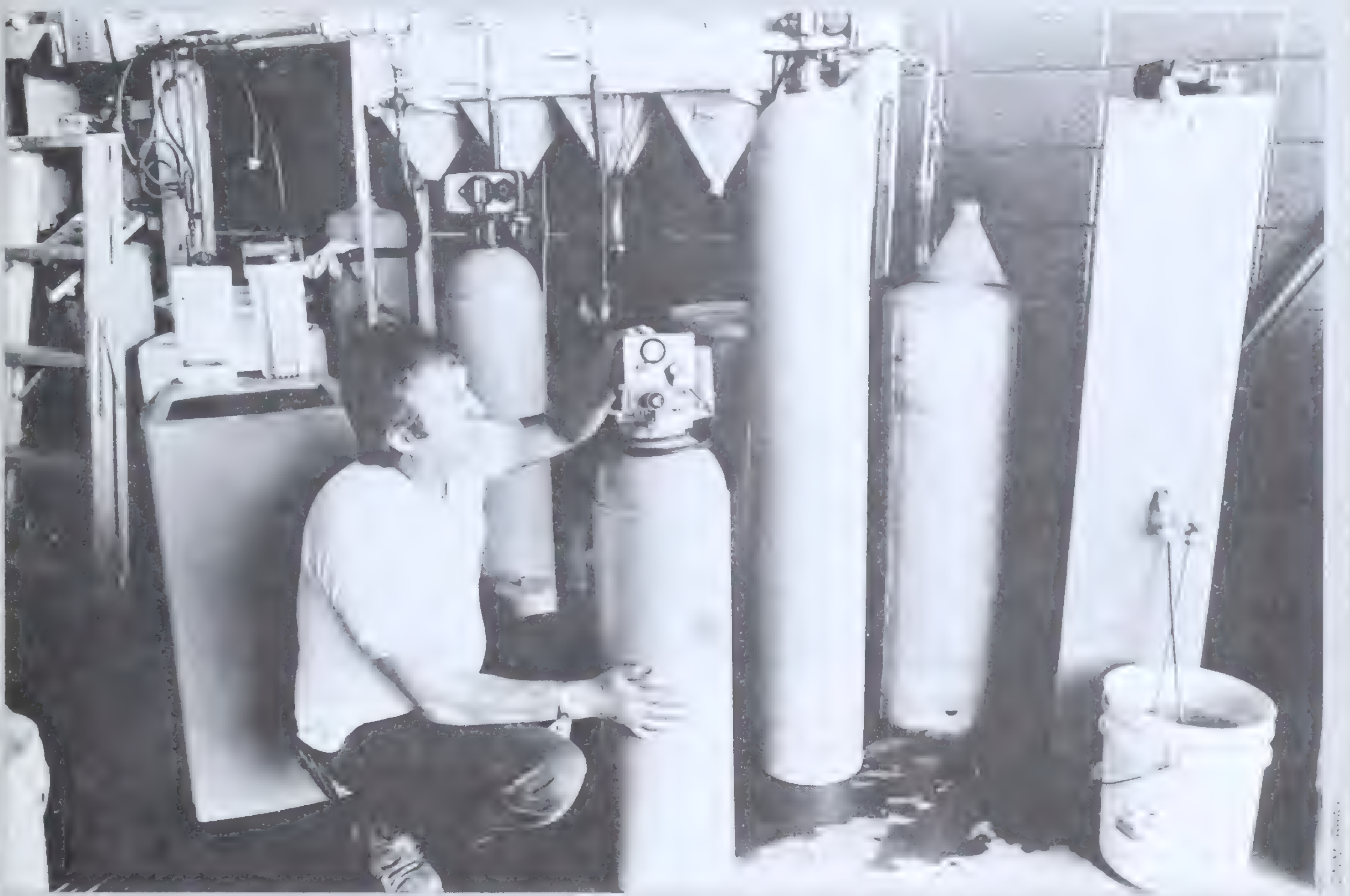
Carbon filters: Over the past few years, Health and Welfare Canada has been studying home filter units, and in 1981 served notice that it was considering banning carbon units altogether. The problem? A carbon filter can provide the perfect breeding ground for bacteria. The bacteria-laden filter then contaminates the water as it passes through. After hearing submissions from the industry and the public, it was decided not to ban these units, but to recommend they only be used with municipally treated water.

Carbon filters improve the taste and odor of water by removing most of the chlorine. They may also remove other organic chemicals, including synthetic pesticide or industrial contaminants and including the unwanted byproducts of chlorination, thought to be carcinogenic.

But some work better than others and all require regular maintenance, including replacing the filters when they are exhausted. For protection against contamination, they should have a system of backwashing to clear the filter periodically. One type incorporates iodine to prevent contamination of the carbon. Another incorporates metallic silver, claimed to have a bacteriostatic action, but not accepted as a disinfectant by Health and Welfare Canada authorities.

There are other types of filters to combat specific problems, particularly in rural areas.

John Kellock with equipment at Black's Water Conditioning



It is possible to spend several thousand dollars on systems with pressure sand filters, iron filters, chlorinators, ultra-violet bombardment, and so on, in an attempt to make dugout water fit for tea.

Distillers: In theory these take out all impurities by vaporizing the water and collecting it in a clean container. In practice, no still is 100 per cent efficient. Volatile chemicals can vaporize and condense with the water, leaving heavy metals (and essential minerals) behind. They are very energy-inefficient — it takes a lot of energy to boil water. In some cases where there is a lot of water being processed there may be a disposal problem: from four litres of water, the yield is about one litre of clean water and three litres of waste water. Distilled water is flat and tasteless.

Softeners: There is a range of these devices available, most of which result in water high in sodium but with much of the magnesium and calcium removed. Softened water is not recommended for people on limited-salt diets. In fact, some authorities recommend that one tap in a house should be unsoftened to be used for drinking, although this adds to the expense of installation. Softened water saves money by reducing scaling in fixtures, pipes and appliances and by allowing less soap and detergent to be used. Distillers need to be kept clean, as they can also be sources of contamination.

Reverse osmosis units: These are often used in combination with softeners, and are claimed to break down water molecules by forcing water through a membrane which removes total dissolved solids, including sodium, letting the "good water" through. John Kellock of Black's Water Conditioning in Edmonton says such devices are "a luxury" which give a very clear, polished water which is excellent for tea, ice cubes and frozen juices.

Bottled water: Not long ago, Canadians associated bottled water with travel to places where the water quality was highly questionable. Then came Perrier and other imported mineral waters, the chic beverages of the health-and diet-conscious. The phenomenal sales of these and such homegrown alternatives as Nanton Water may reflect a lack of public confidence in our municipal supplies or it may just be a matter of an acquired taste.

Whatever the reason, the Nanton Water people are happy. Lee Jackson of HPI Beverages, which distributes Nanton Water, says sales (from nothing to a million dollars in two years) reflect public concern about media reports of dangerous chemicals in the water supply and the growth of interest in nutrition and fitness. Nanton water is taken from an underground source in the foothills near Nanton and receives no treatment except carbonation to make it bubbly, and filtration through a paper filter to polish it.

There are federal regulations on bottled water which require that it be free of bacteria and labelled correctly: municipal water may not be represented as "spring water" and "mineral water" must contain specified levels of total dissolved minerals.

Gerald Moss

Sources and Types of Water Pollution

What's going into our water?

Waste is an expected product of any organism that's alive and vital. Our societies are organisms that seem destined to grow and expand. As we flourish, a good share of the trash we produce spills into our waterways, where we hope somebody or something will take it away.

In the natural scheme of things, one organism's junk is often another's lunch. But when the environment can't absorb the leftovers without suffering, they become pollutants.

The average Canadian uses about 225 litres of water per day and another 6400 litres per day are used for him in manufacturing, cooling, agriculture, and mining. Most of the used stuff comes back to waterbodies with its physical, chemical, and biological character changed.

The physical makeup of a water body is modified when alterations to its temperature, color, clarity, or odor occur. These changes are pollutants when they become harmful to aquatic life or just esthetically unpleasing. In 1973 a British Columbia court found a construction firm responsible for a "polluting deposit" when a bulldozer stirred up enough silt in a stream bottom to smother salmon spawning beds downstream.

Polluting materials are classified as organic, inorganic, or biological in nature.

Degradable organic ones generally have a biochemical origin and are players in some lifecycle process. Micro-organisms in oxygen-rich water bodies feed on these, and break them down chemically to simpler and less offensive compounds.

Although all organics will eventually degrade, microbes will go after the easy ones first. The tougher, so-called non-degradeable compounds can persist for very long times, especially when dissolved oxygen is hard to come by.

"Non-degradable organics have always been with us to some extent," says Dr. Steve Hrudey, "but we keep heaping more into the system — synthetic ones."

UNIVERSITY OF ALBERTA

Dr. Steve Hrudey

Dr. Hrudey is a specialist in water assessment, treatment, and waste management in the civil engineering department of the University of Alberta. He says that man-made organics such as phenols and hydrocarbons will persist for a long time anywhere oxygen is scarce.

Only highly pure distilled water is free of inorganic ions and salts. People not only seem to tolerate a fair degree of mineralization, some find it healthy and, after some bubbles are added, will pay a hefty price for the bottled variety. Inorganics will, however, degrade water at high concentrations, making it brackish and saline.

Many agricultural fertilizers are inorganic compounds rich in phosphorus and nitrogen. Carried by runoff and groundwater to lakes and streams, these nutrients encourage extra aquatic plant and algae growth. As the plants die off and sink, their decay can cause the oxygen demand on the water to skyrocket.

Toxic metals such as mercury, lead, and arsenic that enter waterways can pose serious problems at very low concentrations. They are of major concern in regions where metal mining is extensive or where industries use surface water bodies as the final resting place for their wastes.

Worrisome biological pollutants are those that can cause disease.

Trefor Reynoldson

"It turns out that, as far as pathogens are concerned, cold, relatively clear water is more of a hazard to people than warm muddy water," Dr. Hrudey notes. "Cold doesn't kill, it tends to preserve. Warmer water promotes the growth of a variety of microbe flora that can be serious competition to the pathogenic variety. This means that in winter, cold, ice-covered water sources need more treatment."

Point sources of pollutants are easily identifiable. These 'end-of-pipe' effluents include wastewater outfall from a municipal sewage treatment plant along a river bank and industrial waste holding ponds that discharge to surface waters.

Non-point sources are spread out and diffuse which makes control and management difficult. Examples: water leaching through landfill (garage dump) sites; runoff water from where fertilizer and pesticide has been used; field; cattle feedlots close to surface water bodies, or open pit mines where rainfall runoff can pick up previously unexposed solids and sediments.

Sewage becomes a pollution problem when it robs fish and other aquatic life of the oxygen they need to live.

The dissolved oxygen necessary for fish to live is also needed for micro-organisms to decompose debris. Experts determine how much degradable organic material is present in water and how much demand it will make on the oxygen resources of the water using the biochemical oxygen demand (BOD) test.

When the BOD is high, decomposition of sewage slows down. Microbes that attack the waste look to other dissolved compounds - nitrates and sulfates, for example for oxygen. When this happens, instead of odorless carbon dioxide as the main gaseous by-product, hydrogen sulfide and other foul-smelling vapors are produced.

In Alberta, industries are relatively easy on surface water.

"Our industries are lower water users than the national average," says Dr. Hrudey. "Since there is less water here than around the Great Lakes, less is used. Also because of stable, permeable geological formations far below the surface, there are alternate liquid waste disposal options, in deep wells, which are not always available elsewhere."

Dr. Hrudey says that one industry in Alberta where a major treatment challenge remains for continuous discharges to surface water is the pulp and paper industry. They have high strength organic wastes that can have a high oxygen demand and even treated effluent can mar the esthetic quality of receiving waters by affecting color and odor.

Aeration of industrial effluent from the Proctor and Gamble plant on the Wapiti River, Grand Prairie (below)

Mary Anne Sharp

The slug, or accidental toxic waste spill, can be devastating to waterways. A recent spill of about 140,000 litres of detergent into a river in Ontario by a forest products manufacturer asphyxiated thousands of fish.

Many organic compounds are lighter than water and, when spilled, form a slick on the surface. This covering almost shuts down the transfer of new oxygen from the atmosphere and drastically reduces the dissolved oxygen already there. At the same time those compounds that mix and dissolve readily sweep through the waterbody, carrying their toxicity in killing concentrations until dilution and time clean up the mess.

As well as such industry-related hazards, municipal sewage, landfill, and agricultural pollutants persist as major problems.

Trefor Reynoldson, of Alberta Environment's pollution control division, says rivers in the province are checked monthly for some 60 chemicals.

"The primary impact on both the Bow and the North Saskatchewan is municipal wastewater," he says. "Because the Bow downstream of Calgary is still an eroding, 'foot-hills' river, the major effect of waste-

Maligne River at Jasper

water outfall is excessive weed growth. Since the North Saskatchewan is a turbid, silt laden, prairie river, Edmonton's effluent results in an increased bacterial count downstream."

Landfills produce a leachate, the vile liquid result of rainfall and surface water percolating through decaying grabage and commercial wastes. If it reaches groundwater, where less oxygen is available, even trace amounts of the organic substances present can persist and foul the water. Additional problems exist where landfill sites are used for toxic wastes — industrial solvents, for example.

The Environmental Protection Service of Environment Canada has a study in progress surveying prairie farmers to pinpoint the agricultural chemicals being used. The toxic chemicals co-ordinator for EPS western and northern regions, Mary Anne Sharpe, says that pesticides, herbicides, fungicides and even animal feed additives are being cataloged for closer study.

"The most logical way to look for things that might be pollutants is to first find what's being used," she says. "If a certain chemical shows significant agricultural usage, then we will look for it in waterways, sediments, and aquatic life. If we don't find it there, it's probably degrading and we'll swing our attention to others."

Most industrial and municipal waste is produced and discharged continously. But sometimes waterways are exposed to unusual loads either from bad weather or seasonal effects.

Steve Hrudey thinks that storm water runoff is one of our biggest wastewater management problems.

"It's very expensive to build special treatment facilities for rare occurrences, but a lot of stuff gets into rivers in a hurry when they happen,"he says.

When wastes are dumped into water bodies, experts want to know how and where they move. Even if the waste is only warm water from the cooling of generations equipment at a power plant, the physics of mixing, dispersion, and transport needs to be understood to achieve water quality objectives.

Lakes are complicated "mixing bowls" with inlets and outlets and can be quite difficult to simulate with mathematical models. Because they stratify, forming at least two distinct layers, relatively little vertical mixing takes place. The wind is a significant and unpredictable force in setting up surface current patterns. Once set in motion, the currents persist due to inertia and as the wind changes, new, competing forces swirl and stir the water in very complicated ways, making pollutant pathways hard to anticipate.

Dr. Larry Gerard, a civil engineer at the University of Alberta, studies mixing in rivers.

"Take a point source emptying into a river," says Dr. Gerard. "It's often assumed that effluent discharged at this point is very quickly mixed all across the river. In fact, the material stays in a plume just like out of a chimney stack, only here the stack is under water."

Dr. Gerard points out that material mixes vertically in rivers rather quickly. But stuff injected at the bank will have to move downstream about a hundred river widths before it even begins to reach the other side. Only after a journey downstream equal to four hundred river widths will it be distributed uniformly across the entire waterway.

And when waste is put into a river at its bank, the peak concentration at every point downstream always remains along the bank.

"This is very important in the north," says Dr. Gerard, "where there is a great deal of casual collecting of water along river banks."

Since biological pollutants are of great importance to human health, it's vital to know how fast they die off downstream of a wastewater outfall. Measurements that Dr. Gerard and his colleagues have made at Fort Smith, Fort Simpson, and Norman Wells have shown that biological pollutants don't die off anywhere near as fast as had been thought, particularly when the receiving water body is covered with ice.

Under ice, colder water slows down decomposition rates, less oxygen from the atmosphere dissolves in the water, and less bacteria-killing sunlight penetrates. All of these prolong the lifetime of microbes and stretch out the time before organic compounds break down.

"We also know that an ice covering affects mixing," Dr. Gerard points out, "but we have to find out more about how important it is."

Dr. Gerard is convinced that to meet water quality objectives we must understand the physics of flow in water bodies as thoroughly as we do the biology and chemistry.

Gerald Moss is a physics professor at the University of Alberta who has written a science column for the *Edmonton Journal* and for the *Ottawa Citizen*

Jim Wilson

Pollutants and Toxicity in the Water Environment

Canada's cold water creates some special problems

A recent fish kill on the Elbow River near Calgary

There are more than 1.3 billion cubic kilometres of water on earth weighing in at about 8.1 quintillion tonnes, but the real story of pollution in this liquid environment is found in the individual drop, cupful or riverful that living organisms come into contact with.

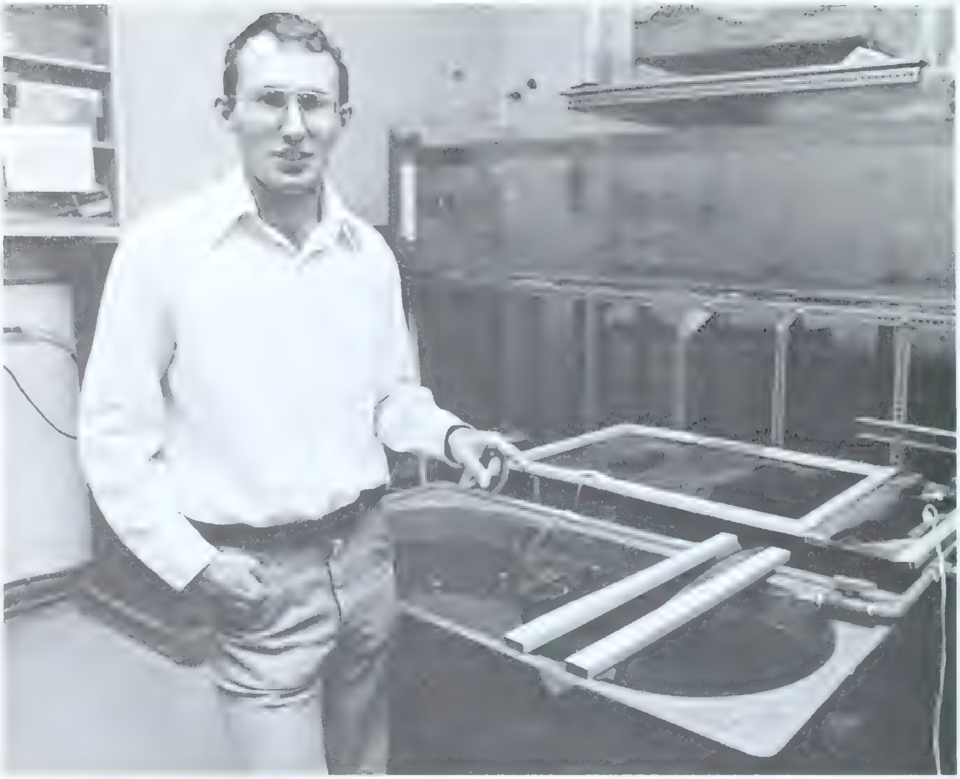
Water is by far our commonest substance and it's virtually a perfect solvent, dissolving and carrying almost everything it touches, so its impure character shouldn't come as a surprise. But that doesn't necessarily mean it's harmful — only that it's polluted.

If we pick up the hydrological cycle with water in its atmospheric vapor stage, even then it is becoming polluted by dust, carbon dioxide and whatever else nature and our way of life spill into the air. As the raindrops land and collect into rivulets and streams they pick up whatever might be in their paths — sediment, agricultural chemicals, sewage effluent as well as natural pollutants ranging from a bit of relatively harmless salt to potentially dangerous mercury.

"In fact it's probably somewhat naive to expect our water to be really 'pure' in our society," says Dr. James Moore, head of aquatic biology at Alberta Environment's research centre in Vegreville. "We're always going to generate pollutants, some of them highly toxic, or else we have to decide to return to an agrarian way of life."

The three most prevalent pollution sources are industrial effluent, domestic wastewater and non-point sources like runoff and storm drainage. And Moore, who says Alberta's water is for the most part quite safe for any living creature, also says most pollutants found in Alberta water come from natural sources rather than being manmade. Manmade contamination tends to be of a local nature and of relatively short duration although it can have enormous impact.

No matter what their source is, pollutants are generally of three types: physical, chemical and biological. Physical pollutants of the water environment would include a variety of siltation and sedimentary materials, and the waste heat created when a warm-water effluent is dumped into a naturally cooler river or lake. Chemical pollutants would include some of the constituents of the sediments, pesticides, herbicides, agricultural fertilizers, heavy metals and industrial and municipal effluents. Biological pollutants include organic wastes, parasites like giardia (the cause of "beaver fever"), coliforms, algae and other living materials.



Dr. James Moore

"They're all harmful to some degree," says Lyle Lockhart, a scientist at the Environment Canada Freshwater Institute in Winnipeg. "But their impact on the environment can vary tremendously."

The most significant factor involved is the level of toxicity of each pollutant in question. Toxicity, Lockhart says, is in effect the death risk to a particular organism caused by exposure to a quantity of a given substance. Researchers establish these risk calculations by exposing the organism involved to graded series of doses of the subject, establishing how much of a concentration in water is required to kill half of the exposed population. That value is the median lethal concentration, abbreviated LC50, and is considered the level of acute toxicity — the level which will generally cause death.

Lesser concentrations can create chronic, or sublethal toxicity, but it's extremely difficult to determine just what the effects are then.

"But there can be more subtle impacts than toxicity," Lockhart says. "It may be that the pollutant doesn't kill the animal or fish, but it deprives them of some essential resource — aquatic vegetation they use for habitat or oxygen for instance.

"The pollutant may also place the organism under a sublethal stress. It doesn't die because of the pollution, but it becomes weakened by it and therefore susceptible to more natural afflictions like disease."

This is believed to be a fairly common problem, Lockhart says, but again, it's hard to measure.

"The other environmental impact is one where the exposed organism isn't adversely affected, but another one is. An example in Alberta is the fish in the Athabasca river and lake that haven't been killed by oily pollutants, but their flesh was inedible last year because of terrible taste and odor."

There can also be both synergistic and antagonistic effects from a combination of pollutants, Lockhart says. "It depends on the pollutants involved. Sometimes the mixture has no more effect than its constituents, sometimes the effects are multiplied and sometimes it's actually beneficial, because the pollutants sort of fight among themselves."

One of the most unfortunate aspects of pollutants is their persistence. Some, such as chlorine, exhibit very brief half-life deterioration periods (the time for half of the measured contaminant to break down). But PCBs and others can take years. And persistence can also depend on physical location: oil on the surface, for example, is relatively volatile and will disappear much more quickly than oil trapped under ice.

"In fact not much happens with most pollutants in the winter," Lockhart says. "Canada is actually a sort of worst-case situation, because the winter retards pollutant breakdown. Than makes it dangerous to accept data on the affects of any chemical on our environment when the research was done somewhere like Kansas City or Japan. Actually, Canada is rather weak in this area and we need more field testing to learn about local affects."

Even when the pollutants do break down quickly they can have a continued deleterious effect. "Generally the breakdown products are less toxic, but not always," Lockhart says. "Sometimes, for instance, the organisms in the water make a slight change in the substance so they can get rid of it in their urine, and these altered substances can be carcinogenic or harmful in some other way."

Dilution can help in purification because toxicity relates to the dose and concentration. But again this isn't simple. For fish whose natural habitat is a diluted but still polluted river, the effects can be much more extreme than for a group of fish that simply swims through, because the effects may be cumulative over time.

Another danger of dilution, Lockhart points out, is that it can actually spread the contaminant further afield.

Whether the organism lives in the water or simply drinks it is another factor: we deliberately chlorinate our water and run it through copper pipes because those things in the concentrations involved are both fairly harmless and useful to us as water drinkers. But fish could be killed in that same environment.

The life stage and physiology of the affected organism can also make a difference to toxicity. For example a fat individual can stand substantially more exposure to DDT because the chemical is attracted to fatty tissue, where it becomes relatively benign. But when the animal begins consuming its fat it is reexposed to DDT. And DDT in the fatty tissues of mother seals can be transferred to their pups through lactation. (This provides a sexual factor: the male organism has no such means of expelling such contaminants.)

Still and all, Alberta's water is pretty clean, and there are several government departments that test it frequently to keep it that way. Bill Lake is head of the Vegreville bioassay section —a group that monitors the province's river and other water sources with industrial effluent toxicity particularly in mind. Bioassay (or biological assay) technology is a rapidly growing field, and is used to determine the effective strength (potency or toxicity) of a substance by comparing its effect on an organism with the effect of a standard preparation of the same substance.

And aquatic biologist Moore's department has similar responsibilities.

"We've examined the chemical residues from fish in all major water bodies in Alberta," Moore says. "Nowhere have we found a pesticide contamination problem. PCBs (polychlorinated biphenyls) occur everywhere, but nowhere in Alberta do people have to be concerned about their appearance in food. And it's the same for other contaminants we've specifically measured — they're not present at harmful levels."

There's also virtually no danger in Alberta from food chain concentration of contaminants, he says. "We have a small population and a small industrial base," he says. "It's not like southern Ontario where things can be so packed in and polluted that you literally see red water and green air in a place like Burlington. Our agricultural land isn't as intensively farmed, so there's less herbicide and fertilizer getting into the water. We just don't get enough pollutants to affect the food chain at its lower level."

There have, however, been a couple of local exceptions to this rosy picture, but Moore emphasizes the words "local" and "exception". He and his associates have found fairly high levels of oil and grease in the Athabasca River system, at times at levels harmful to fish. "It's not effluent from Suncor I'm describing here — it's the natural result of water flowing through the oil sands region," he says.

Another exception is the North Saskatchewan River, where tests two years ago showed levels of mercury just below the danger point in tested fish. The source is believed to have been several old industrial plants in Saskatchewan including an abandoned fertilizer plant and a pulp and paper mill that previously used mercury in its manufacturing process.

"But there were natural sources as well," Moore says. "The Tobin Reservoir in Saskatchewan and the river channel itself would also produce background quantities of mercury — that's a common situation."

It's also a potential problem when the giant Slave River dam projects begin in northern Alberta.

Nothing can really be done about that sort of pollution, Lockhart says, but he notes the North Saskatchewan is slowly cleansing itself. At one point a couple of years ago the mercury concentration was about four parts per million. Today it's down to one part per million, compared with the generally accepted completely "safe" level of 0.5 ppm. At one part per million it is safe for adults to have a couple of fish dinners a week, although pregnant women should avoid eating fish caught in the river.

There are also examples of fish kills due to chlorine from time to time, the most recent one being in the Elbow River. But Moore says these situations are generally the result of normally harmless pollutant concentrations aggravated by decreasing summer water levels and the lower concentrations of oxygen in water heated by summer sun, not because of any dangerous pollution.

"If we could transfer that same water and materials and the fish to a cold Arctic lake the fish probably wouldn't notice it at all," he says.

Sometimes, political or philosophical judgment calls create deliberate pollution situations, where one danger is measured and traded off against another. Recent heavy insecticide sprayings in Winnipeg to combat mosquitoes carrying equine encephalytis are one example. And in southern Alberta powerful herbicides are routinely used in irrigation canals to kill heavy weed growth. They also kill fish in the canals — but the political decision in that case is that the water is more important than the fish.

No one minimizes the existing problems or potential future difficulties, but Alberta may also be fortunate there: oil wells leave enormous holes deep in the ground when they go dry, and many of our more worrisome wastes are dumped into them.

"It's probably one of the best things we could do," Moore says. "Most of Alberta is sitting on a bed of oil, and if Mother Nature can keep her act together for millions of years without letting it poison the surface world, we should be okay if we dump our toxic wastes into the same holes."

Steve Hrudey, a University of Alberta civil engineering professor agrees — to a point. "On one hand the use of deep wells has saved our surface waters from being exposed to pollutants. After all, there's always going to be some percentage of pollution remaining after we treat our water, and that goes back into the water systems where there's a potentially dangerous impact. However, if we dump our contaminated water into deep wells, we get in effect 100 per cent purification.

"But it's dangerous to consider deep wells a solution to every problem, and they shouldn't be used indiscriminately for all types of wastes. There is some finite probability of failure here, however slight. That means that if we wouldn't want the contaminants to be let loose in any surface purification system failure, we shouldn't dump them into deep wells either, for the same reason."

Jim Wilson, marketing co-ordinator for the Calgary engineering firm of Reid Crowther and Partners Ltd., is a freelance journalist

Beaver Fever?

It's not really fair to blame the poor old beaver for the spread of giardia, better known as "beaver fever" — particularly since the infection's source appears really to be, well, us humans, if the embarrassing truth be known.

In fact since giardiasis (the proper name for the problem) creates symptoms including lengthy periods of diarrhea, weight and appetite loss, flatulence, cramps and a generally grungy feeling (but despite the name, no fever) and since experts say it's likely caused by the poor outdoor toilet habits of many forest visitors, the beaver folk themselves might prefer to call it "Beavers' Revenge" after its distant Mexican relative.

Whatever it's called, giardia is hardly a dangerous affliction. "It's the mildest sort of parasitic infection around," says Dr. Peter Wallis, professional associate with the University of Calgary's Kananaskis Centre. "During the 1950s experiments were done with volunteer prisoners in which they were infected with giardia to provide a model for study of other and more dangerous parasites."

No one, he says, has ever died from giardia, although a few people do react rather badly. And if it is contracted, treatment with Flagyl, an anti-protozoan drug, removes giardia from the system within a few days.

Giardia is a single-celled zooflagellate protozoan parasite of the order Diplomonaidia — a fancy description for a pear-shaped, single-celled critter with two nuclei and eight flagella (leg-like appendages) with which they attach themselves with a sucking organism to the mucosa in their hosts. In its younger stage it appears as an egg-like "cyst", fairly resistant to the normal environment. In that stage it can live for about two months in water and is not adversely affected by infrequent freezing, so it can even survive the winter.

The prisoner experiments, Wallis says, showed that infection by at least 10 such cysts is necessary in humans for giardiasis to occur. In the human or animal host, the parasite enters its more active feeding stage, attaching itself to the gut — and that's also where it produces new cysts, which are then expelled with fecal material.

Its incubation period is six to 22 days, after which giardiasis symptoms will occur in most carriers (some people appear to contract the cysts, carry the parasite — and not exhibit any symptoms). And since it spreads through fecal contamination, it can run through a relatively enclosed population such as a day care centre in a very short time.

Giardia is common worldwide, and has been around for centuries. "In fact it's one of the first things Antonie van Leeuwenhoek identified when he started developing his microscope" says Dixon Thompson, a professor in the faculty of environmental design at the U of C.

Thompson has become one of the beaver's champions of late. "We've shifted the blame from where it ought rightly to be," he says. "Wild beaver and other animals may be carriers, but the virulent forms really originate with people — and that's where we've got to take action to deal with the problem."

At least 10 per cent of us are believed to carry giardia at any given time — and as Thompson points out, "There are a lot more people for you to meet than there are beavers."

In numerous research studies, while beaver, muskrats and even dogs have been found to carry giardia, the main carrier always seems to be humans. Even where there have been mini-epidemics of beaver fever (that name, by the way, appears to have been coined by a Toronto Globe and Mail writer or editor during the 1981-82 giardiasis outbreak in Banff) there has never been a specific link to beaver — or to community water systems either.

"It's not likely that giardia is carried by the water systems," Wallis says. "There's probably some possibility it could happen, where the community has surface water supply and no filtration system, but you'd need a whole lot of infected beaver to infect Calgary or Edmonton's water supply. Really, unless you make a habit of drinking water from beaver ponds, you're unlikely to contract giardia from the water — it's much more likely to be the human fecal-oral route."

That's actually fortunate, since chlorination isn't a very good means of doing the giardia parasite in — it would take so much chlorine the water would be undrinkable. Filtration works best: the kind of system found in most larger cities' water treatment facilities. Other than that, the only way to treat infected water is to identify the source (infected ground or animals upstream for instance) and remove it — and then wait while the water purifies itself.

Stopping the spread of giardiasis might be simpler in the long run.

Both Wallis and Thompson say a trowel should be one of the camper's basic tools. "Dig a small trench about eight inches deep to bury your fecal material — and don't do even that if you're close to moving water," says Thompson. He says where burying is difficult or impossible, such as for mountain climbers contending with rock faces, the only solution is to carry fecal material out in plastic containers.

It's not just the beaver's reputation that's at stake in the desire to instill better toilet habits in outdoor visitors, and it's not a small matter. In Europe it's dangerous to drink the water even in high mountainous country. In Canada that fresh, pure and wondrously delicious cold mountain water is becoming more and more often contaminated with tiny, microscopic cysts. And boiled water just doesn't taste the same.

— Jim Wilson

Susan Rikley

How Effluents are Treated

A review of the options

Probably the last thing we think about in the course of a day is where dishwater disappears to after the dinner dishes are done, what happens after the toilet is flushed, or what becomes of chewed-up carrot peelings after the garburator is buzzed.

We drink on average, only four litres of water per person a day. But we can count on using and discarding up to 180 litres for a five-minute shower, 22 litres to flush the toilet once, four and a half litres to brush the teeth. Every day we discard water — and the soaps, dirt and foods that go with it – from our dishwashers, automatic laundry machines and neighborhood car washes.

Each year in Alberta, we spend millions of dollars to maintain various types of sewage systems which transport our wastewaters out of sight and out of mind, and return them to our water bodies in a considerably cleaner state.

Not surprisingly, a community's rate of sewage flow will be related fairly closely to the amount of water it consumes over a given time. Daily peaks in flow are commonly recorded between 8 a.m. and 10 a.m., at noon, around the dinner hour and at bedtime.

Water consumption rates will be higher in drier, irrigated areas in the south and lower in northern Alberta. We can assume that a community will consume about 250 to over 450 litres of water per capita per day.

A municipality might generate up to 30 per cent more or less sewage flow than the amount of water it uses in a day, depending on such factors as degrees of infiltration and exfiltration of water within its system of pipes, extent of lawn-watering and types of commercial or industrial operations hooked into its system.

In comparison to their urban counterparts, Alberta's smaller communities tend to be more conservative in their consumption of water and, consequently, in their generation of sewage flow. Their people and homes tend to be older and without as many household water-consumptive conveniences, observes Joe Milos of Alberta Environment's pollution control division.

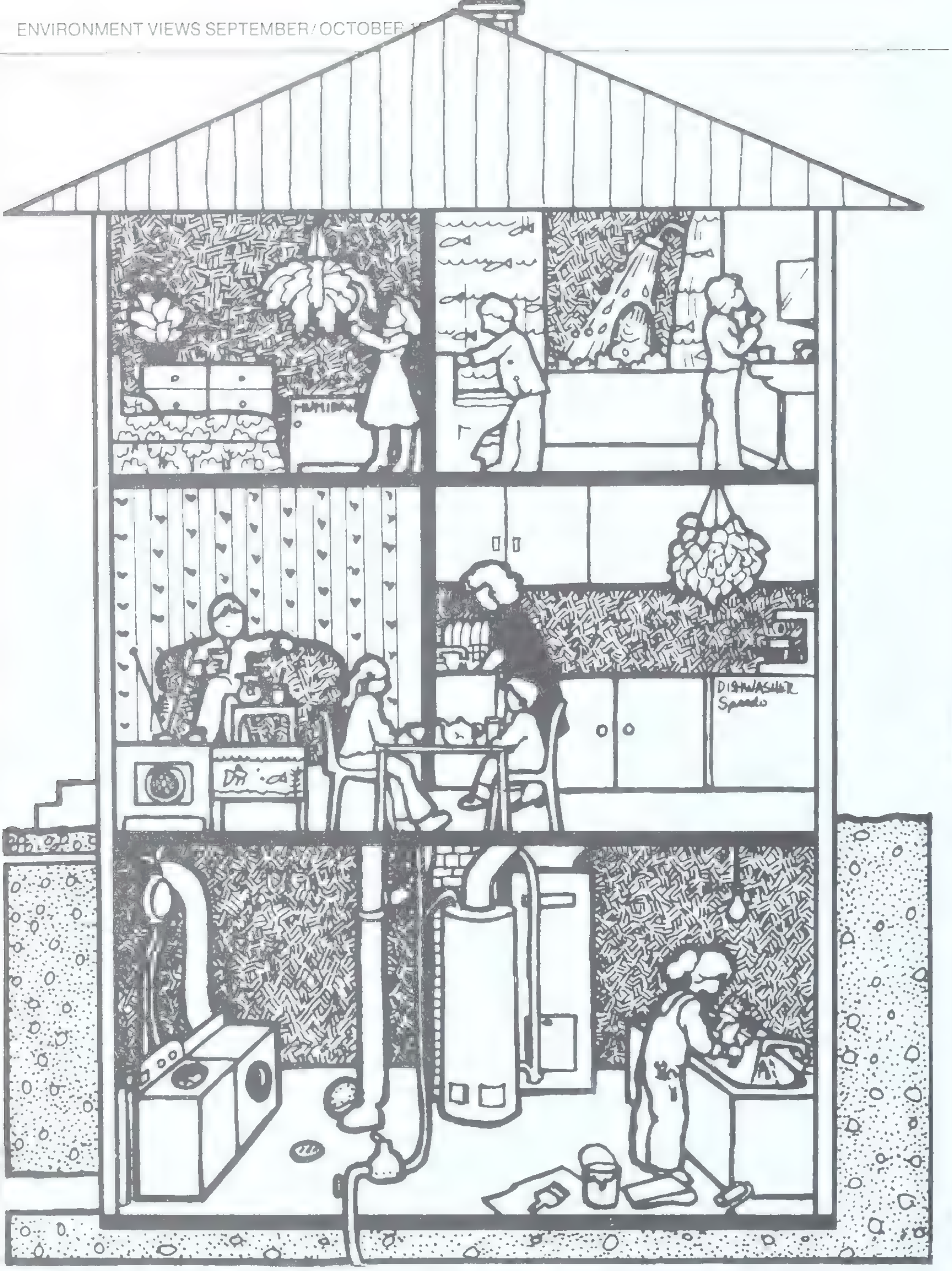
Smaller communities are also likely to be without major commercial or industrial establishments which can account for the majority of total wastes in larger cities.

Every year, says Milos, one or two troublesome situations will arise in which a municipal treatment system is under too heavy a burden from industrial or commercial discharges.

The city of Lethbridge, for instance, found soon after completion of a new treatment plant in the early 1970s that its system was already overtaxed by industrial wastewaters – notably from food-processing operations which generated wastes high in hard-to-treat organic material. Forty per cent of that community's raw sewage and 60 per cent of its actual waste strength were being produced by seven commercial/industrial establishments.

After looking at various pre-treatment options, city officials decided to build, with financial commitments from the industries, a separate plant to pre-treat industrial wastewaters before passing them on to the main municipal plant.

Raw sewage is, as Steve Hrudey describes



Albertans consume between 250 and 450 litres of water per capita per day.

Joe Milos

it, something of a "thick organic soup." Conventional treatment processes have traditionally aimed at removing 'objectionable' materials from wastewaters: rags, papers, human feces and partially-decomposed foods, dirt and grit, suspended particles, and other organic impurities. Despite the presence of such matter, raw sewage is usually 99.9 per cent pure water.

Wastewater treatment plants are rarely designed to treat water to drinking quality, and large numbers of micro-organisms remain in wastewater plant effluents. Disease-causing organisms are killed in the water we drink through disinfection, usually with chlorine, at water treatment plants. If a community's drinking water is supplied by a surface water body, the plant will draw water from somewhere upstream from where sewage effluents are released.

Influent is what arrives via a community's sewage pipeline system for wastewater treatment. The cleaned *effluent* has received full treatment and is released to the receiving water body.

Some widely-applied processes and treatment stages are described in the following paragraphs. It should be kept in mind, however, that treatment systems vary in complexity among municipalities.

Preliminary treatment — Large objects which have been washed into the sewers could obstruct flow in a treatment plant if not caught at this first stage. Branches, rags and other types of garbage are screened out. Stones, sand and street-sweepings may settle into grit tanks.

Primary treatment — In quiet conditions, many waste-water impurities which are present as suspended particles will settle out by gravity. What sinks to the bottom of primary settling tanks will be removed as primary sludge. Grease, feathers and other floating scum may be scraped from the top of the wastewater.

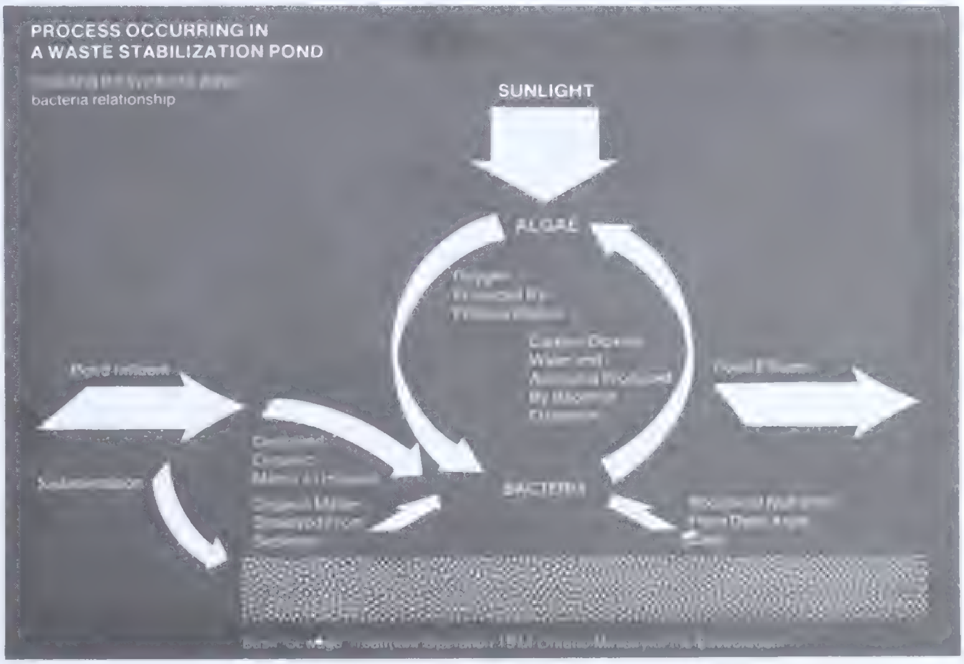
Secondary treatment — At this stage, organic matter remaining in the waterwater will be treated so that the effluent which will be released does not exert a high oxygen demand in the receiving waters.

In treating wastewaters, soluble and colloidal organic matter can be removed through the same types of reactions which allow rivers and lakes to assimilate certain amounts of organic matter. Mechanical means are commonly employed in treatment plants to hurry along these natural biological processes.

The *activated-sludge* process, or modifications of it, are used by most municipalities in the province with mechanical treatment plants. The concept was developed around the turn of the century and is widely used in conventional processes.

By supplying them with oxygen, the treatment process encourages micro-organisms in the wastewater to feed on the remaining organic matter, to grow and to convert it into a cellular mass, which eventually settles as sludge. Part of the sludge is recycled as hungry bacteria into the incoming sewage. The rest of a plant's sludge may be fed into digestion tanks where micro-organisms cannibalize each other, and the sludge increases in concentration and decreases in volume. The cleaned effluent has now been fully treated and is released into its receiving waters.

Rotating biological contactor (RBC) systems, relatively new to North America, have been adopted in the past decade by a handful of communities, among them Fort Macleod, Devon, Innisfail, Olds, Canmore and Nanton. In an RBC plant, dozens of plastic disks, 10 to 12 feet in diameter, rotate slowly in a wastewater tank. Micro-organisms grow and cling to them as a slimy film, and receive oxygen as the disks turn into the air. Biological breakdown continues, the film grows thicker, and pieces eventually fall out



Private Systems

Home and cottage dwellers in the countryside face a responsibility which few urban residents encounter: they need to be sure that their own private systems of sewage disposal are properly and safely maintained.

Although country residents seem to be becoming more aware of the potential hazards related to improper sewage disposal, public health inspectors receive complaints every year from people who discover sewage in puddles in lowlying land or ditches on or near their properties, says Lew Goddard, environmental health services supervisor for the Leduc-Strathcona health unit.

Such discoveries are usually made by residents of acreage subdivisions or hamlets without community sewage systems.

In many cases, the local soil simply will not absorb any more effluent from the buried perforated pipes, known as the tile field, from a household's septic tank. In other instances, private systems have been poorly serviced and allowed to overflow, sewage effluent has been illegally pumped into roadside ditches, fields, gardens or playgrounds, or effluents have been trucked away and dumped at improper sites.

Raw sewage or effluents at the land's surface pose a potential health hazard: if they are to contain disease-causing bacteria, they could become the source of transmission of waterborne diseases. It's not uncommon for children and pets to come into direct contact with puddles of effluent during their play.

And although open sewage problems have so far been localized in nature, says Goddard, it's possible that effluent from improper disposal, if not corrected, could in time work its way into groundwater drinking supplies.

Goddard says, however, that in the past couple of years increasing numbers of hamlets have been installing communal collection systems within his health unit's jurisdiction and, he believes, in other parts of the province. The systems have been established by local counties generally at the recommendation of regional health and plumbing inspectors.

When a complaint arises over a particular property owner's problem within his health unit's jurisdiction, health authorities meet informally with the owner and the local or provincial plumbing inspector to discuss how the system can be improved. Often the informal meeting helps solve the problem and eliminate the need for legal action, he adds.

Aerial view of sewage lagoons, Town of Entwistle, near the Pembina River

as sludge.

As old-fashioned as they may sound, *lagoons* — otherwise known as waste stabilization ponds — are in fact very effective in their treatment of wastewaters. The quality of their effluents is as good as or better than that of large treatment plants. "Once they're built," Joe Milos observes, "not a lot has to be done. Nature does it for you."

Treatment time will be a matter of months, perhaps a year, with lagoons which are aerated naturally by wind and waves. But during this time, a high percentage of organic material is decomposed and few residual waste products are left to be disposed of. Some communities pump oxygen into their ponds to speed up the process to a month or less and keep the land area they need for the lagoons to a minimum.

About 85 per cent of Alberta's communities treat their wastes in lagoons; about 15 per cent use mechanical methods. Rural households which are not connected into municipal treatment systems usually have private septic tanks.

Municipalities must, as set out by provincial standards, apply secondary treatment processes to their wastewaters. A few must take further measures, sometimes referred to as tertiary treatment, before they release their effluents.

The city of Calgary, for instance, has this year cut its release of phosphorus in effluent waters by about 75 per cent with its new phosphorus-control facilities. The phosphorus-control program was initiated in the late 1970s at provincial request in response to public concern about weed growth in the Bow River. Phosphorus is present in wastewaters from household detergents and bodily wastes, and is a major plant nutrient.

Capital costs associated with the phosphorus-control measures will amount to about $31 million. Alum, the precipitant used in the chemical-precipitation treatment process, will cost another $2 million per year.

A few communities are required to disinfect their wastewaters. Among them are Devon, Cochrane, Canmore, Banff, Fort Macleod and the Evan-Thomas development site in Kananaskis Country.

A municipality may be requested to disinfect its wastewaters if it is located a relatively short distance upriver from another's drinking-water supply (as in the cases of Devon and Cochrane) or if its effluent flows into a water body from which recreational users might be tempted to drink (as in the cases of Banff and the Evan-Thomas site, where people might drink what they believe to be 'pristine' mountain water).

There are some who believe that disinfection should be a common practice in wastewater treatment. Daniel Smith, of the University of Alberta's civil engineering department, believes it's not enough to rely upon a municipal water treatment plant, which is subject to failure, as the only means of defence against transmission of waterborne diseases. He points out that wastewater disinfection is more widely practised in the U.S. for public health purposes, including the protection of recreational users.

For most cities, the handling and disposal of sludge is a costly part of sewage treatment. Sludge disposal can represent from 40 to 60 per cent of the total costs of treatment for mechanical plants, says Dave Graveland of the technical development branch of Alberta Environment's earth sciences division.

Moreover, traditional disposal methods (landfills, for instance) have had no beneficial effects for either humans or the environment, he says. In the past eight years, however, sludge has found favor among municipalities and landowners as a slow nutrient-releasing fertilizer and soil conditioner. Now, an estimated 80 to 90 per cent of the sludge produced in the province finds its way to fields of farmers who in many cases are reporting large increases in crop yield.

Treated sludge is applied in varying degrees to lands in Ontario, B.C. and Manitoba, in the U.S and in European countries. In Alberta, the trend began with a successful pilot project in 1975 by Calgary. Edmonton, Red Deer, Lethbridge and a large number of towns have since followed its lead.

Grains have not shown statistically-significant accumulations of toxic metals or trace organics, notes David Spink of the department's standards and approvals division. However, leafy vegetables are among crops unsuitable for sludge application.

Re-use of wastewaters has become of increasing interest to industries with hard-to-treat wastes and/or difficulty in meeting provincial effluent standards. A number of food-processing, gas-processing and fertilizer-manufacturing industries in Alberta are applying their wastewaters (high in organic or nutrient content) to land for irrigation purposes.

Other industries with high water demands are recycling waters for their own operations. Oilsands surface-mining operations, notes Steve Hrudey, are aiming to satisfy about half of their water demand from wastewaters recycled from their tailings pond.

Susan Rikley is an Edmonton freelance writer and editor

Re-using Wastewater

Surface application of sewage sludge

Just how clean our wastewater effluents from municipalities and industries are, and should be, has become a matter of considerable discussion and varying points of view.

Some say we should be striving not simply to treat the wastes we produce, but to attain an ideal state of zero discharge — zero pollution — which they recognize will not be an overnight achievement.

That would mean, for instance, that water returned to a river after use would be as clean as, or cleaner than, it was when it was drawn out, says Martha Kostuch, a member of the pollution study group of the Public Advisory Committee to the Environment Council of Alberta.

Municipal sewage treatment plants have traditionally been geared to treat biodegradable organic matter and grit material in wastewaters. But in recent years, concerns have arisen over other elements — notably heavy metals and hard-to-measure chemicals — in wastes from human-use products, industries and agricultural practices. Most organics (80 to 90 per cent) are removed in municipal sewage treatment processes. Some metals and chemicals are removed during secondary treatment, but not all.

Steve Hrudey, of the University of Alberta's civil engineering department, observes that municipal sewage treatment in this province is generally better than elsewhere in Canada. By necessity, in part. Alberta's cities don't have the 'option' of dumping their wastewaters into an ocean, for instance. Although Ontario's treatment standards are perhaps as high, he says, "on a population basis, I don't think there's any other place in Canada where a higher percentage of sewage is treated."

Industries which treat their own wastewaters are subject to site-specific effluent standards set out by Alberta Environment in permitting the plants' construction and operation.

Despite rapid growth during the boom years, Alberta produces significantly less total industrial waste than, say, Ontario where findings of toxic pollutants in the Great Lakes have created worry. Joe Milos of Alberta Environment says that although routine screening is performed for trace contaminants — which are hard to detect with modern testing technology and, if they were found, hard to treat —this province doesn't have the numbers or the types of industries which would warrant a massive program of checking for and treatment of chemicals.

One step toward an ultimate goal of zero discharge is the re-utilization of wastes. As long as sewage is considered as simply something to be treated and disposed of, Dr. Kostuch says, we are losing sight of a valuable resource which can be used in productive ways.

Although some progress in re-utilization has been made, she says, government should be offering further incentives for exploration of all re-use possibilities.

Among such incentives could be assistance for research programs and for identification of markets for waste products. An agency has been formed in Ontario, she notes, to let producers of industrial wastes know of other industries which might use the ingredients those wastes contain. And industries and municipalities could be charged for use of our water and air for their effluents, she says.

Zero discharge advocates say efforts should be made to control pollutants at their sources — efforts, for example, to improve industrial processing technologies so that fewer heavy metals are passed on to their wastewaters, to investigate toilet systems which need less water and so produce less municipal wastewater, to remove certain contaminants from household products so there's no need to tack on sophisticated treatment technologies at the municipal plant.

Although it was "totally rejected not many years ago," zero discharge is a concept which is being given serious consideration as a goal we are going to have to achieve despite the difficulty and the expense, says Dixon Thompson of the faculty of environmental design at the University of Calgary. He cautions that efforts should be directed not to "all substances," but to those identified as significant pollutants.

Dave Graveland, of Alberta Environment in Lethbridge, says generally industries "are not bashful about coming forward and saying, 'we will have problems'" in treating wastewaters or meeting effluent standards. The philosophy of wastewater re-use is, he says, regarded by a number of industries as "a pretty viable alternative."

A dozen or more food-processing, gas-processing and fertilizer-manufacturing industries are applying their wastewaters (high in organic or nutrient content) to land for irrigation purposes. Some don't discharge at all into surface waters.

Another 20 to 25 municipalities — small communities in the southern part of the province including Taber, Granum and Crossfield — have been applying community wastewaters to land as irrigation waters. Municipal sludges are commonly used in Alberta to fertilize land and condition crops.

Communities with systems which rely on irrigation as their sole method of effluent disposal are generally asked to own and lease their own lands or to come up with iron-clad agreements with those who use the water, says David Spink of Alberta Environment's standards and approvals division. He also notes that logistics, land requirements for stored wastewater and questionable benefits come into play in considering the suitability of wastewaters from larger municipalities for irrigation re-use.

Wastewater re-use for irrigation is not viable in all cases, Graveland notes. Waters high in sodium content or heavy metals would not be suitable, for instance.

Other industries are recycling their process waters for their own operations. Many modern plants separate their cleaner from their dirtier waters by means of segregated sewer systems, then re-use the cleaner waters.

Surface-mining oilsands operations have been aiming to satisfy more than half of their water demand from wastewaters recycled from their tailings ponds, Steve Hrudey notes. At Syncrude Canada Ltd., about 70 per cent of the plant's process water requirements has been met by water recycled from the wastewater tailings pond.

Hrudey believes, however, that there are disincentives which can work to discourage industries' exploration of re-use options. Use of deep wells for wastewater disposal by industries, for instance, has been beneficial in preventing pollution to surface waters in Alberta, but offers little economic incentive for developing technologies for treating of wastewaters for re-use, which would entail greater costs.

Maryhelen Vicars

Your Role in Cleaner Water

From your kitchen sink to the river

For most of us city-dwellers, effective sewage disposal is very much taken for granted. It may be surprising, therefore, to learn that our household habits can have a lot to do with how well these systems work.

And, of course, effective sewage treatment has a lot to do with the quality of the water in our rivers and lakes — and, ultimately, the quality of our drinking water.

The capacity of sewage plants is dependent on two different but related functions: hydraulic and organic loading.

Hydraulic loading refers to the volume of water going to settling tanks; organic loading refers to the amount of organic material entering the system.

Treatment plants are set up to treat a certain concentration of organic material in waste water, says David Spink, of Alberta Environment's standards and approvals division, municipal engineering branch. If that concentration is altered by the addition of either more water or more organic material, "you start to have problems."

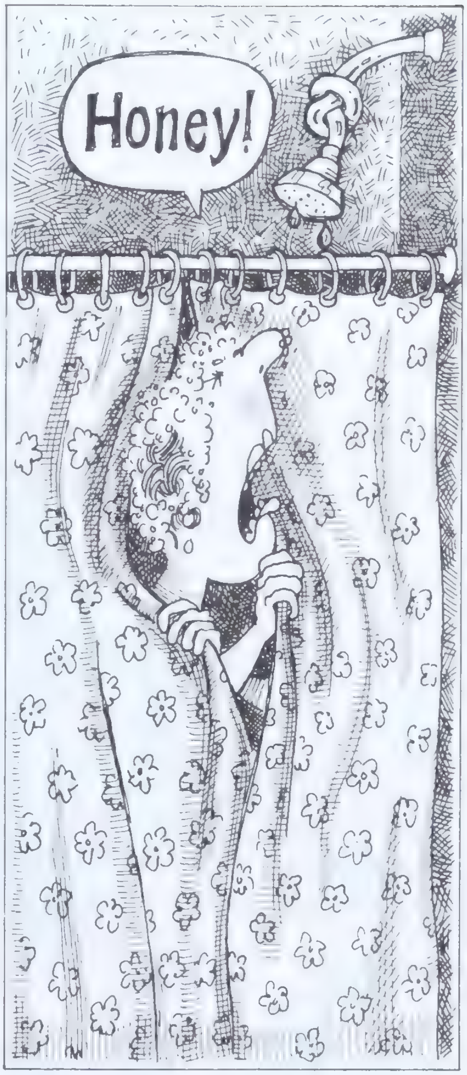
In this part of the world, fresh water is plentiful and fairly inexpensive, so most people use — and dispose of — far more water than they need. This adds to the volume of household sewage and dilutes it, putting a strain on the system.

"It's easier to treat a lower volume of high-concentration waste than a higher volume of low-concentration waste," Spink says.

Household sewage problems, whether caused by too much water or the wrong kind of waste, can be greatly helped by an increased awareness of the householder's responsibility.

"There's no way we can cut down on the amount of solid matter we excrete each day," says Peter Lawson, a Calgary pollution control consultant, but most other contributions to the system can be controlled to some extent.

Interviews with Lawson, Spink and other authorities in the field yield a kind of checklist for consumers. Their advice:



WARREN CLARK

Don't waste water.

In the toilet tank, a plastic bottle filled with water and weighted with small stones will reduce the amount of water used to flush —about 24 litres in a conventional toilet. A publication of the United States Environmental Protection Agency (EPA) suggests not using bricks. They may flake and clog tubes and valves. If you're replacing a toilet, consider a water-saving model which uses only about 14 litres.

Learn to take "sailors' showers." Turn off the tap while soaping up and shampooing — you'll save soap as well as water. A short shower takes far less water than a bath in a full (240 litres or more) tub.

Repair leaking toilets and taps. To test if your toilet is leaking, the EPA suggests, put a few drops of food coloring in the tank. If color appears in the bowl without flushing, there is a leak.

Don't let the taps run needlessly. Clean razor and toothbrush with short bursts of water. A bottle of water kept cold in the refrigerator eliminates the need for running the tapwater until it feels cold.

There are a number of water-saving devices available. B.C. Hydro provides "flow restrictors" for their residential customers. A kind of plastic washer, they're installed in the shower head to cut down on the amount of water flowing through it.

Modified shower heads, some adjustable, are available which also reduce the flow of water from the "normal" 24 litres per minute to as low as 10 litres per minute.

Householders need a little encouragement to save water, it seems.

Cal Johnston, manager of waterworks for the City of Calgary, says his department has commissioned a study of 10 Alberta municipalities comparing water use.

The study found that in communities where people pay a flat rate, water consumption is 53 per cent higher than in communities with metered water.

In Calgary, where most consumers pay a flat rate, the average per capita per day use of water is 806 litres; in Edmonton the figure is 509 litres.

The amount of waste water produced, according to figures provided by Spink, reflects this proportion.

In Calgary in 1979 the average household sewage flow was 677.8 litres per person per day. For Edmonton the estimated figure for last year was 480 litres per person per day.

While Calgary has less porous soil and drier weather which may call for more lawn watering, Johnston says the significant difference is the use of water meters.

Paying for the amount used encourages thrift, apparently.

Just finished cleaning. I'll turn on the garburator and be right out.

Forget the garburator.
Widespread garburator use can increase a system's organic loading by as much as 30 per cent, according to a Colorado study. Instead of food scraps going into the sewer, they should be put in the garbage — or better still, composted in the garden.

"This is something which shouldn't be going into the rivers," Lawson says. "It should be returned to the soil as part of nature's cycle."

While some communities have banned garburators because of the extra organic loading, no Alberta towns or cities have done so, Spink says.

Also adding to the organic load, although on a smaller scale, is the common practice of dumping kitchen waste down the toilet. These mouldy leftovers should go into a container and then out with the rest of the household garbage.

Fats should never go down a drain, Spink says — they "gum up" the collection system. They can be collected in a jar and thrown out.

Your toilet is not a wastebasket.
Such things as paper diapers, dental floss, hair or plastic tampon holders can create havoc in the treatment plant. They should all be tossed in the wastebasket, not the toilet.

Lawson says disposable diapers are an "absolute menace." When first marketed, they were advertised as "flushable," but the extra burden of paper was found to clog both toilets and treatment plants.

As for anything else that might be tossed into the toilet, follow this rule of thumb: toilets are for toilet tissue and wastes; *anything* else should be directed into the wastebasket.

Yech! This water tastes terrible! They should do something about it!
SOLVENT
PAINT

Watch the chemistry of your sewage.
Heavy industry is not the only source of toxic chemicals. In comparing sewage from industrial and non-industrial areas for the presence of heavy metals, Spink says researchers found a surprisingly high level in non-industrial areas. While many of these metal contaminants — cadmium, for example — come from food sources, a significant amount come from household products, from the zinc in shampoo and baby ointment to lead in paints which are cleaned from brushes then dumped with solvents down the sink.

While consumers can help by reading labels and substituting degradable products wherever possible, Spink suggests that for heavy metals and other synthetic chemical contaminants, changes may have to be made at the manufacturing level. When phosphate in detergent was found to cause algae to flourish in receiving waters, choking their oxygen supply, during the late 1960s, industry was compelled to drastically reduce the level of phosphate used in detergents. This cut was phased in over five years, Spink recalls. "Each year, as the level dropped, there was a noticeable improvement."

Paints, solvents, pesticides and oil-based compounds should never be washed down a drain, and putting flammable liquids into the sewer system contravenes most sewer bylaws, for obvious reasons.

When DDT was banned, some sewage treatment systems were severely hampered as many householders, in a hurry to get rid of the chemical, flushed it down their toilets and into the sewage system, where it wiped out large populations of bacteria.

Householders should resist the temptation to use the storm sewer drains found on most streets as a handy disposal outlet for garden chemicals, paint solvents and the like.

In most cities the storm sewers are part of a separate system which is intended to carry rainwater more or less directly to the river, bypassing the treatment given household sewage.

This article was adapted from *The Consumer Has A Role to Play, by Maryhelen Vicars, Environment Views Vol. 3 No. 1, April/May 1980.*

Jim Wilson

Water Quality Legislation and Enforcement

Should society get tougher?

The saturated body of a human is 65 per cent water, and virtually every earthly organism, from the tiny amoeba to the tallest tree, is at least half water. And every day, each of us needs about three litres of fresh and unpolluted water just to stay alive.

No wonder, then, that we attempt to regulate the quality of water in our streams and water systems. And particularly in Alberta, no wonder that we're concerned about the impurities in our rivers and lakes: Alberta is the headwaters location of some of Canada's most important watersheds. And since water is always moving, regulatory ramifications extend into a variety of municipal, provincial and even international jurisdictions. If we're incautious in Alberta, we can pollute water consumed by people in Saskatchewan, Manitoba, the United States — even the countries bordering on the Gulf of Mexico.

Still, whether a water user who has dumped polluted effluent into a river has committed a criminal act or has merely been unfortunately careless or over-regulated depends on your point of view. If you're a fish who has watched all your brothers and sisters die, the dastard who did it deserves nothing but the worst. And if you're a fisherman who can no longer make a living because there are no longer edible fish to catch, the government had better prosecute the polluter — and provide financial assistance in the interval.

But there's another side: if you're a community or industrial plant, struggling to stay afloat in today's economic quicksand and perhaps operating a facility built to specifications of the past, all you're doing is your best, and if that's not good enough, well, what's a poor fellow to do?

In all cases, the problem is water quality and the unhappy source of wrath is the legislation and regulations that define water quality and how to maintain it, and set the limits beyond which "pollution" occurs.

(Pollution, it should be noted, can refer in this context to harmful substances, heavy quantities of silt or other inert but nevertheless physiologically overwhelming materials — and even too much extra heat in the effluent.)

"Yes!" is the vociferous, one-word answer from pollution control officer Joe Milos when asked whether Alberta's water is "clean". But Milos, of Alberta Enviroment's pollution control division, municipal engineering branch, rapidly qualifies his response. "It really depends on what you, or the regulator, or the general public, mean by 'clean water'. We don't really live in a very sterile world in other contexts, and most public health measures are designed to deal with things we *know* are harmful. But sometimes when we talk about 'water quality' we get into the area of things that *might* be harmful. Then if we find them in the water, we start to change our perception of whether or not it's really clean."

And the above example of the surviving fish isn't really facetious: by both right of legislation and prior use, "water users" include aquatic life as well as us humans.

Alberta's water quality is really quite heavily legislated. On a national level there's the Fisheries Act and its regulation and guidelines, and Canada Water Act, the Navigable Waters Protection Act, the Safe Drinking Water Act and an extensive body of court orders and precedents. There's also the Insecticide, Fungicide and Rodenticide Act and Toxic Substances Act, both of which limit the handling of such poisons near watercourses, and from a different point of view, there are numerous water treaties among the provinces and between Canada and the U.S.

Provincially, there are the Alberta Clean Water Act, the Litter Act, the Municipal Government Act (and local by-laws resulting from it), other legislation and also the right of various government departments granting operation licences and permits to industries and municipalities to set extensive, detailed standards which the licencees must constantly meet.

At least in theory, all this legislative authority carries a very big stick.

"The Fisheries Act is a good example of our powers, and it's probably also our strongest legislation," says Ray Mackowecki, northeast regional director of Alberta Energy and Natural Resources' fish and wildlife division. "The Fisheries Act Section 31 says that no one shall destroy or even tend to destroy fish habitat. And Section 33 makes it unlawful to add any deleterious substance to a water body frequented by fish. These are pretty far-reaching definitions — virtually all the watercourses in the province can be classified as fish habitat."

However, he adds, there can be significant enforcement problems when it comes to defining "destroy", or "deleterious", or even "fault" in terms of who or what created the water contamination.

On the surface those definitions appear to be straightforward. The Alberta Clean Water Act, Section (1) (p) for example, specifically defines "water pollution" as:

"(i) The presence in water of any contaminant in excess of the permissible concentration prescribed by the regulations for that water contaminant, or,

"(ii) a change of temperature of water in contravention of the regulations."

Under normal circumstances, operational licences and permits specify exactly what these permissible levels and temperatures are.

Unfortunately in reality, it's not so open-and-shut.

In a report prepared last September for the Environment Council of Alberta by environment consultants M.A.H. Franson, R.T. Franson and A.R. Lucas (Environmental Standards: A Comparative Study of Canadian Standards, Standard Setting Processes and Enforcement) the authors point to the great similarity among water quality legislation packages in most Canadian provinces and of the federal government.

But they add: "Environmental standards are nearly useless if there are no effective mechanisms for assuring compliance . . . . There seems to be a regrettable tendency on the part of lawmakers, the public, and commentators to assume that laws enforce themselves. They usually do not."

Indeed the common criticism by environmentalists is that Alberta's — and most Canadian — legislation is too discretionary, and therefore too toothless to be properly enforced. It's easy to find examples to support this concern. For instance the Alberta Clean Water Act and other pollution control acts are full of such qualifications as "The Minister *may* . . ." and "The Director of Standards and Approvals *may* . . . and even Section (15) (1) (re Stop Orders): "If the Minister is satisfied that a person (a) has contravened or is contravening this Act or a regulation or order under this Act . . . the Minister *may* issue a stop order to that person."

JON MURRAY

David Spink

In other words, the Minister is *permitted* to order the alleged polluter to stop doing whatever it is that is creating pollution – but he has the discretion not to do so.

Wes Smart, of the Alberta Enviromental Law Centre, says this isn't likely as big a concern as it might appear. His larger worry is the decided infrequency with which prosecution of heavy-weight legislation orders take place.

"It may well be," he says, "that problems of enforcement in Alberta might arise because of lack of use of the legislation that exists — there have been fewer than 50 prosecutions in the province since 1971, for example, which means there's little experience in actually carrying enforcement through."

Smart says this is due to the provincial government's philosophy that its administrative system works so well, and its record of industrial and municipal compliance with regulations is so good, that prosecutions are almost never needed.

And it's true that Alberta seems to take a decidedly different approach to pollution control than most jurisdictions: the buzzword here is "negotiate".

"You really can't write legislation and guidelines to cover each situation," explains David Spink, of Alberta Environment's standards and approvals division. "We issue licences based on discussions about the particular kind of facility involved and the realities that implies. Where they have tried to develop standards to cover all situations, they're a disaster — it takes weeks to figure out where to begin, and if there are problems later, it takes weeks to figure out where to go."

And ENR's Mackowecki describes what generally happens when pollution is suspected: "We always contact the company or municipality first, and our follow-up action depends on how they respond."

Trefor Reynoldson, of Alberta Environment's pollution control division, agrees with this approach. "First we go to the company," he says. "We don't take the big stick approach — we avoid antagonism and try to negotiate. The result is that we have very few discharge problems here, and a good working relationship with plant operators."

Reynoldson says most of the department's raw data comes from the licensing requirements which make companies and municipalities file monthly reports with the government, outling measured effluent values and indicating whether they're above or within tolerance levels.

"The plants report everything to us including their own violations, because they trust us," he says. "We have reasonable faith in them, without that being meant to sound naive. But if we antagonized the companies by jumping on them every time there was a problem, they wouldn't report violations."

Lawyer Wes Smart says he doesn't really object to that approach, except where long-term problems occur. "But we have to remember that the data involved is really for management purposes and it's historic — the past month. Companies do have to report major incidents (major licence violations) immediately, but that's not necessarily going to help in terms of prosecution if it comes to that, and it's certainly a curious circumstance where we're expecting a company to collect evidence to be used in court against itself."

Alberta's government departments have no on-going independent inspection to see that water users are complying with their licences and regulations, Smart says, and that's the first place the system can break down. If industry and municipal authorities are completely honest, of course problems should be few.

But there's also a problem of inexperience and unpreparedness, he says. "There is no well-organized prosecution team that's ready to take a case," Smart points out. "Alberta Environment does not have a full-time solicitor who is qualified to provide legal advice concerning licencing restrictions, enforceability and general administration.

Wes Smart

"And, there's the extreme difficulty of getting evidence that can be used in court —and the lack of a departmental solicitor who knows how to use that evidence."

A ticklish case, currently before the courts in Alberta, illustrates these problems. Suncor Inc. is accused of a number of infractions involving materials found downstream from its Athabasca River plant. When the government decided to take Suncor to court (after investigation indicated a problem and it felt negotiation had failed), only one lawyer was assigned to prosecute — against a team of legal experts fielded by Suncor. (Eventually the prosecution was expanded, but not before the first lawyer collapsed in exhaustion.)

The Suncor case is also a good example of some of the difficulties with evidence that can arise in water quality legislation cases. Since the presecution had no effluent monitoring records of its own it used the report values submitted by Suncor in routine compliance with its operating licence. Suncor deftly defeated this thrust by calling expert testimony that its monitoring system was not really accurate enough to be trusted.

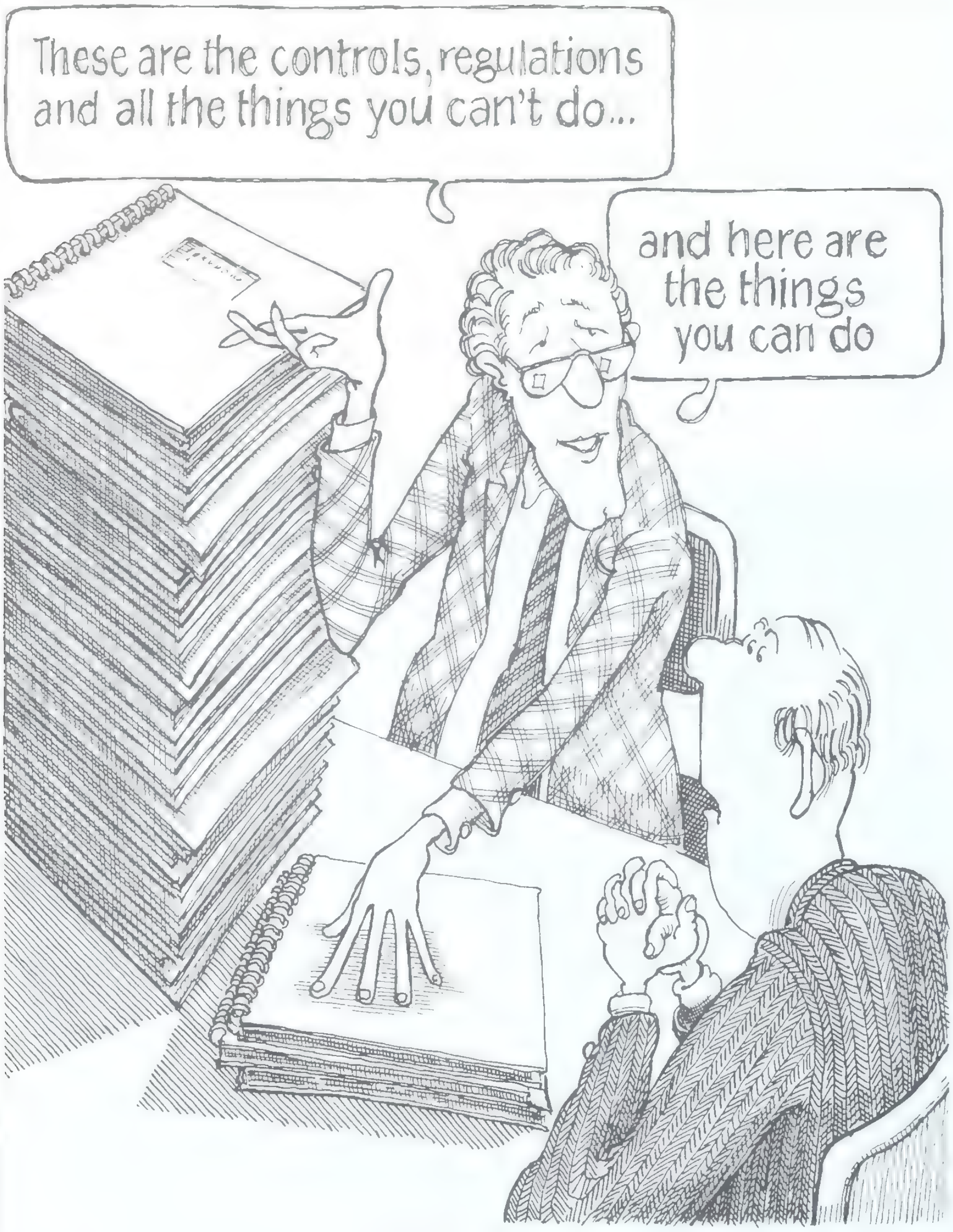
Finally, the case helps to illustrate a concern with the adequacy of fines for those found guilty of breaking water quality laws. Potential fines are frequently criticized for being too low to start with: $1,000 for failure to provide reports, for example, or $25,000 for failure to comply with either the terms of licence or with a control order issued to solve a pollution problem. But the courts tend to treat the assessment of guilt as the major penalty, adding fines at the lower end of the scale. In one of the 21 charges against Suncor, where the company was found guilty, the maximum fine could be $50,000 but was only $ 8,000.

(Suncor is appealing this disposition, as is the Crown appealing several cases the courts have dismissed. Both parties expect the charges to be before the courts for some time.)

Suncor says its current effluent is within all licence limits. "We're not in a position to respond further or discuss measurements taken in the past because of our court case," says Wayne Antler, of Suncor's public affairs department. "But our licence specifies a number of absolute limits, and we're meeting them."

And Ray Mackowecki, who was involved in the original government investigation, concurs. "There have been very few 'events' (brief periods of excessive contamination) recently — and nothing that has disturbed us according to Suncor's licence."

But even if legislation is beefed up, and


These are the controls, regulations and all the things you can't do...
and here are the things you can do

even if various government departments organize specialist enforcement sections, it still wouldn't necessarily be enough. Licences and permits would still have to be worded clearly, and means of successfully taking prosecutions through the courts would have to be found.

The Franson-Lucas report lists a number of virtually meaningless "requirements" in several licences the authors inspected. For instance, one B.C. condition simply states: "Monitoring will be required as specified by the Director from time to time." And an Alberta condition requires that sampling stations "shall be maintained at suitable locations in the vicinity of the plant and operated at a frequency satisfactory to the Director of Standards and Approvals."

The report comments: "Monitoring requirements of this type are not likely to be enforceable. They may be adequate so long as no disputes arise. But authority to impose disputed requirements is the essence of enforcement."

Another frequent court problem is what is known as the "due diligence" defence – the evaluation that the concept of "strict liability" doesn't necessarily apply in environmental cases, and that if the accused took reasonable care to avoid any violation of his permit requirements he is not guilty of an offence even if provable pollution occurred.

This, Franson-Lucas say, will require that prosecution teams become much more technically proficient, both in terms of investigating and collecting evidence, and in dealing with the accused in court.

So far, Alberta's regulators and regulatees appear to have generally avoided creation of an antagonistic atmosphere. Negotiation, by and large, seems to work and operators of plants which suddenly begin creating pollution seem generally to repair the damage — at least to the requirements of their licences and the interpretations of government officals.

"There's sometimes a public perception that there's a water quality problem in Alberta, and that's partly our fault," says Alberta Environment's Reynoldson. "I think we've been lax in distributing information in an easily-enough understood fashion."

That's why, he says, many of the environmental group complaints make it appear the province is superficial in its enforcement of clean water legislation. "Sure, we have specific cases where we get low dissolved oxygen which can result in severe weed problems and dying fish. But those things are much more often the result of weather temperatures and low water levels in the streams than from anyone polluting things. There will always be those problems, and there will always be times when industrial plants accidentally or even purposely dump contaminants into a river. But so far we've managed to handle these things — and we're constantly improving our record."

And at least one engineer in the industrial world agrees.

Gary Webster, an environmental engineer with Dome Petroleum, says he resents the blanket implication that industry always pollutes and that its employees simply don't care.

"There are a lot of us who work in industry who have a direct effect on company policy, and we care about the environmental quality of the community we live in. Generally it's also easier to keep the environment clean and to comply with the regulations than to risk the problems of breaking them."

And he has an observation on Alberta's philosophy of negotiation rather than prosecution: "I would hate to see it get to the point of a pitched battle where all the government's resources and all the industry's resources are used to fight against each other. I'd much prefer to see all that money — or even a tiny bit of it — spent on solving whatever the problem is, no matter whose fault it might be."

Jim Wilson, marketing co-ordinator for the Calgary engineering firm of Reid Crowther and Partners Ltd., is a freelance journalist.

Helen Corbett

The State of the Water

They're catching salmon on the Thames again

When a farmer's cattle caught tuberculosis downstream from Edmonton in the mid-1940s, the dramatic need for improved sewage treatment was never more evident.

Then came the discovery that the city's primary sewage treatment was badly contaminating the water downstream. Complaints about color and odor could be heard all the way to John Diefenbaker's stomping ground, Prince Albert, Saskatchewan.

"We'd punch a hole in the North Saskatchewan River ice and it looked like a septic hole, with toilet paper and everything else in there," recalls Patrick Bouthillier, professor of civil engineering at the University of Alberta.

Contrary to popular belief, Alberta's lakes and rivers are not more contaminated today that they were in the past. True, they are now subjected to an increasing load of sewage effluents, industrial wastes and agricultural chemicals. But in terms of sewage treatment, the rivers are considerably cleaner than in the past.

"Historically, the North Saskatchewan is a good deal cleaner since the later 1940s when the river's content of dissolved oxygen was almost totally depleted," says Steve Hrudey, professor of civil engineering at the University of Alberta.

The water was affected 96 kilometres downstream, exacerbated in winter months when the river was covered in ice.

After a concerted campaign, Edmonton's secondary sewage treatment facilities came onstream in 1955, effectively reducing the taste and odor problems and restoring the river's oxygen level.

The Bow River also went through a similar cleanup, after a major public outcry resulted in secondary sewage treatment facilities at Calgary in the 1960s.

The last two decades have seen an enormous growth in our cities, introducing a new level of complexity to our already strained sewage treatment centres. Today, the discharge of sewage effluents poses the greatest threat to the quality of Alberta's water. Nowhere is this more evident than in the case of the Bow River.

As Calgary has grown, vast amounts of nitrogen and phosphates have been added to the river through sewage wastes. These nutrients act like fertilizers for a flourishing growth of aquatic weed and algae.

"Not only are the weeds an unpleasant thing esthetically, they cause problems with the oxygen level of the river," says Alberta Environment's Hal Hamilton, a limnologist in the surface water section of the water quality branch. "They clog up water resource structures and impart an unpleasant taste and odor to the water."

For years, communities downstream from Calgary have complained about health problems associated with the water quality. Their point was dramatically illustrated in 1981 when 25 of 28 members of a navy cadet

THE GREAT LAKES REGION

Patrick Bouthillier

Hal Hamilton

canoeing group became severely ill after drinking water from the Bow.

"The Bow came into focus years ago when the fish were dying," says Elmer Kure of the Environment Council of Alberta's renewable resources study group. "Since the river was stabilized, it's turned into a world-class trout fishery. But the mass of weed growth means it's only a matter of time before it becomes a dead river."

Hamilton is confident this won't happen now that Calgary has installed advanced phosphorus removal equipment at its sewage treatment plant. He estimates phosphorous will be reduced by 80 per cent, while leaving some enrichment to protect the trout fishery.

The nutrient loading of rivers from sewage effluents has prompted Kure's group to press the government for higher treatment standards.

"All the major urban centres in Alberta are using watercourses as sewage dumps," he says. "We expect the province to lead the way in setting standards and not wait until the rivers are dead to start expensive corrective measures."

The group has asked the government to explore three ways to improve the sewage situation: require all cities to use tertiary treatment; use effluent wastes in irrigation; and explore the use of effluent waste in the oil and gas industry for heavy oil extraction.

One of the most dramatic cases of remedial action has been the case of England's River Thames, where a purification scheme reclaimed 48 kilometres of polluted water downstream from London. There sewage and industrial wastes had killed most of the fish in the river's lower reaches.

"The biggest problem in London was the number of sewage outfalls running into the Thames which dated back to the Middle Ages," say Noah Hynes, a limnologist at the University of Waterloo.

The British solved the problem by connecting all the sewage pipes to trunk lines that transported the effluents to tertiary plants further downstream, eventually discharging the treated wastes in the tide water.

"What had been 48 kilometres of totally deoxygenated water slowly recovered until now the water is good enough for salmon to come back," says Hynes. "Only Chicago has done better; there they reclaimed 480 kilometres of sewage fungus down the Illinois River."

Halting and restoring the contamination of our watercourses is expensive, prompting some governments to experiment with control at the source. West Germany has recently started a program of user fees applied to industries and municipalities according to the amount of waste discharged into water. The level of fees increases annually, thereby "making it economical to build waste treatment plants," says Norbert Schmidtke, an enviromental consultant in Kitchener.

In the case of the Great Lakes, the com-

The Dickson Dam on the Red Deer River wi
ensure a water flow — and oxygen supply — sufficient to allow fish to survive the winter

bination of intense industrialization and concentrated urban pupulation has led to an enormous build-up of pollutants over the last 40 years. Lake Erie is estimated to have aged 15,000 years before it would have naturally, from the load of industrial and farm pollutants flowing into it. Erie's weed-choked waters led one ecologist to call it "too thick to drink, too thin to plow."

The first campaign to clean up the Great Lakes came about in the 1940s when towns and cities began to install sedimentation and disinfection facilities for sewage wastes.

"These measures brought about massive improvement, once sewage began to be disinfected with chlorine," says Dr. A.L. Hamilton, senior economic advisor to the Great Lakes Water Quality Board, the watchdog authority of the International Joint Commission (a permanent body set up by the U.S. and Canada to deal with water levels, pollution and regulation along their common frontier, including the Great Lakes).

By the late 1960s, eutrophication of the Great Lakes emerged as a primary problem. This abated somewhat as progress was made in reducing phosphorus loads in the lakes.

"Now concern is shifting to toxic chemicals bioaccumulating in the lakes," says Dr. Hamilton.

Sophisticated and deadly chemicals and pesticides have shown up in the water as quickly as they've been developed. DDT, PCBs (polycholorinated biphenyls), Mirex, Lindane, Aldrin; and the most deadly one of all, dioxin, so hazardous that 1/200 of a drop can kill.

"These are persistent chemicals that will have a bearing on human health," says Hamilton. "Last year our board made 16 recommendations on areas we felt the governments have not met their commitments. Now we're asking them to take steps in dealing with these pollutants."

Industrial pollution has not had the kind of devastating impact on Alberta water quality as in eastern Canada. Why?

"Before the 1950s there wasn't much industry to speak of in Alberta," says Bouthillier. When the government began to control and monitor water quality, they took off the shelf the latest and best treatment. By the time industries began to develop, there were standards to be met as far as oils, grease, color, odor, biological oxygen demand and toxic materials were concerned."

The type of industry also has a bearing on the kinds of pollutants entering a water body.

"Despite the fact we have a petrochemical industry, it's on a primary level," says Hrudey. "Not as many synthetic organics flow into the water. The more concentrated discharges are handled by deep well disposal."

Nonetheless, industrial wastes do get into our rivers and lakes whether discharged directly, transported through the atmosphere or by erosion due to landclearing. Industrial wastes accounted for 33 per cent of the effluents in the Bow River Basin in 1980.

"We monitor for 22 metals and of those, only eight have been found above the level of analytical detection," Hal Hamilton says of the basin. "As far as heavy metals go, we

Mike Hawkins of Edmonton's Goldbar sewage treatment plant

essentially don't detect them in the systems. That's not to say they aren't going in — they are — but the inputs are at a very low level and tend to associate with river sediments."

Lakes in Alberta haven't suffered the same kind of industrial contamination as their counterparts in the east. Eutrophication, however has been very widespread here, happening naturally in most cases, and hastened by man in others.

"Most of our lakes are big eutrophic sloughs, perfect for ducks," says Bouthillier. "Astotin Lake at Elk Island Park receives no sewage, but it's as thick and green as pea soup."

Sewage wastes have hastened weed growth in Pine Lake and Pigeon Lake causing cottagers to arrest the situation by pumping out their sewage.

Thermal heating of water in Wabamun Lake, west of Edmonton, has caused growth of nuisance weeds and algae. There, a power generation plant uses lake water for cooling. The effect of heated effluent on water quality has caused concern to native people, recreationists and commercial fishermen.

Lake Athabasca, where commercial fishing is an important source of livelihood for the local native people, has recently faced industrial pollution. When traces of phenols and heavy metals showed up in lake fish, the commercial fishery was closed and court proceedings brought against Suncor for its tailings pond effluent discharges.

Overall, there is some consensus that the quality of Alberta's lakes and rivers is fairly good.

"Basically in my view, water quality is a pretty minor problem, apart from a few hot spots," says Trefor Reynoldson, head of surface water section of the water quality branch. "Certainly in global terms, our situation pales in significance."

But as urban centres continue overloading sewage systems, more chemicals are used in agriculture and industry, and resource development puts strains on water supply and quality, there will be an increasing need for vigilance in guarding the quality of Alberta's water.

As history so aptly demonstrates, we humans don't really appreciate something until we're in danger of losing it. This is the story of water, our most undervalued resource. In Alberta if we adopt and enforce the highest standards for our water we may avoid some of the drastic restoration measures required for the Great Lakes, the Thames and Illinois Rivers.

Lord Byron's words are pause for thought:

" . . . *Til taught by pain,*
Men really know not what good water's worth."

Helen Corbett is a former journalist now working as a freelance writer and film maker out of Canmore.

Susan Bramm

Riverside Classrooms

A "hands-on" approach to studying water quality

LILLIAN HAMPEL

BILL McKEOWN

Lillian Hampel

On a number of sunny afternoons this spring, groups of teenagers could be spotted along the banks of the North Saskatchewan River — not truants gone fishing, but science students armed with notebooks, water chemistry analysis kits and sampling cylinders.

For two years their teacher Lillian Hampel of McNally Composite High School has involved her students in a "start-to-finish" scientific research project that at the same time helps Alberta Environment monitor water quality in the province.

Hampel was the first of nine teachers in Alberta to participate in a pilot of the Water Quality Education Program. It is sponsored by Alberta Environment, the brainchild of biologist Trefor Reynoldson of Alberta Environment's pollution control division.

Reynoldson was looking for a way to continue and expand the biological monitoring program initiated by Alberta Environment in the 1970s. His inspiration to get students involved sprang from what he had observed in his native England. There, school science clubs often maintained meteorological monitoring stations. As well, water pollution study kits were given to students interested in contributing to a national water quality survey.

In 1980 Reynoldson proposed that the department similarly involve science teachers and classes. "The concept is that the schools will operate fixed stations for a period of time. We'll have a network of schools on a river system. For example at Edmonton (on the North Saskatchewan River) there might be four or five schools involved . . . They'll pool their data so that the students will get an appreciation for what's going on in the environment and how the systems work. We will keep an ongoing data bank for the rivers in the province. And it will allow us to identify problem areas, perhaps before we could have normally."

In early 1981, Reynoldson, Susie Washington, then Alberta Environment's environmental education co-ordinator, and Lillian Hampel set out to design and test such a program. Hampel prepared the necessary materials: two manuals, one for teachers, the other for students, each containing appropriate information on how to carry out and write up the project, and a 59-page key to aquatic invertebrates of Alberta. In April of 1981 Reynoldson and Washington assisted Hampel and her students with their first field sampling at two locations on the North Saskatchewan River.

Since then the program has been revised and used by eight other teachers whose classes have conducted field studies in the late fall and early spring.

Ephemerella (below); oligochaete (below right).

The program focusses on invertebrates found on or in the bottom sediments. Some of these creatures survive best in relatively "unpolluted" water conditions while others thrive and dominate where conditions are just the opposite. Aquatic biologists call these "indicator species", that is, their presence (or absence) reflects the total chemical and physical state of the water environment over time.

For Hampel's classes who have sampled upstream and downstream of a sewage treatment plant, "the results are very extreme —certain groups are notably missing in the downstream site and being replaced by large numbers of other organisms so there is a very definite difference between the two sites that the students can see readily." For example, "You are going to see stoneflies, mayflies and some caddis flies at Groat (upstream) and these will be fairly rare at Beverly (downstream) but you will see lots of Chironomidae and Oligochaetes at Beverly and very few stoneflies", she says.

The invertebrates are collected in a device with a fine mesh net to trap the animals. They are carefully removed and preserved in alcohol. Back in the lab, these are examined under a dissecting microscope and identified. The relative abundance of the different types of invertebrates is also noted.

The project involves about four hours of pre-field trip study, a day for sampling at the river, and at least ten hours for laboratory work and project write-up. Each student is expected to complete a thorough, scientific report of the project, incorporating the class data into the discussion and conclusions.

The data received to date have correlated well with sampling results obtained by Alberta Environment. This lends greater relevance to the exercise, considered an important factor by teachers and students alike.

The opportunity to learn from people directly involved in water pollution monitoring is also seen as a bonus. "This is something that they (the teachers) haven't been able to get from an in-service program or from a university program — to actually be working with field technicians and a trained biologist", says Jim Martin, of Alberta Environment's communication division.

Mike Hrab of Grand Centre High School, whose classes have been sampling the Beaver River for the past two years, says that his students really enjoy getting out of the classroom, that this project "is much more attractive than a standard lab exercise." Peter Harris of Ross Sheppard High School in Edmonton found that it is a useful adjunct to the Biology 20 curriculum, which emphasizes ecology.

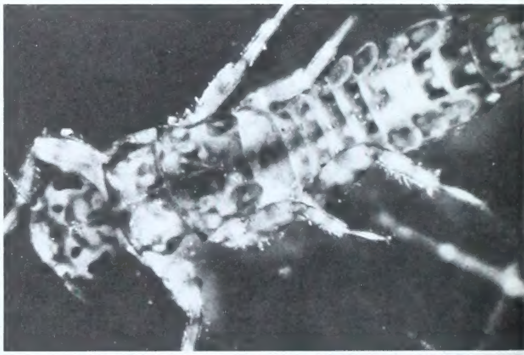
For most of the students this has been the only high school project done outside of the classroom. Yet it has had a dramatic impact on their appreciation of the subject. "I sure think a lot more about water now," says Jennifer Kenworthy of McNally Composite High School. Classmate Greg Suess agrees. He used to innocently look over the North Saskatchewan River, but now he views it differently: "it looks pretty clean but now I know what the quality is actually like . . . and that it (the water) has a lot of different things in it."

"Science in schools is a lab experience, in real life it is not", says Susie Washington. Washington thinks that this program makes a start at "fostering serious, thoughtful consideration of the facts — necessary for responsible decision making. Because it leads the students through a series of steps that begin with observations and measurements in the field, but requires data analysis and research before conclusions can be drawn, they learn to avoid the ever-too-common 'leaps of assumption' ", she says.

Reynoldson feels that this type of program could be applied to other fields of study, such as air pollution (using lichens) and acid rain (using pH kits), or even general surveys of vegetation and animals. "This is the thin edge of the wedge for environmental work in schools. I think that it is absolutely critical that people have a good understanding of the implications of their life and lifestyle on the world about them, and the school is the obvious place to start."

With revisions made to the original materials and the positive response received from participating teachers and students, Reynoldson, Martin and Hampel are hoping to expand the program. This fall they will conduct two workshops at the Alberta Teachers Association Science Council meeting in Red Deer. And like the student sampling program, it will be a "hands-on" experience.

Susan Bramm is *Environment Views'* researcher and a member of the editorial board of the magazine



T REYNOLDSON

LILLIAN HAMPEL

Prepared by Jim Martin

Using Environment Views in The Classroom

Water Quality

Though water plays a pervasive role in our lives the abundance and quality of the water that we have in Alberta is often taken for granted. The water that touches us most often comes out of a tap and our waste water goes down the drain. This physical separation from source and receiving body of water is at the heart of much of the indifference that society in general and certainly school students in particular have in regard to water. Even though Trefor Reynoldson of the Water Quality Branch of Alberta Environment may have room for optimism when he states that, in Alberta "water quality is a pretty minor problem, apart from a few hot spots," the situation cannot be considered static, especially when consideration of increased demand in the future is made. Throughout time this 'quality' could deteriorate. It is important that students develop an awareness of what is considered quality water now; identify the present problem areas and why; put water quality in an historical perspective; and develop an understanding of how future demands and technology could effect over-all quality.

This opportunity for education is supported, at least partially, in the *Program of Studies*. Though the opportunity for both empirical study and dealing with the issues from a values approach is evident, only the high school sciences (especially biology) offer direct access to the curriculum. The social studies curriculum does not directly deal with water quality issues. Teachers should involve their students in elements of the issues through discussion and current events.

Relationship to Curriculum

Social Studies

The major issues concern the right of the individual to a safe water supply and the role of society in the protection of our water supply. Some general issues for discussion and further research in grades 9-12 include:

Should government legislation and enforcement be given more teeth to deal with water polluters?

Should the goal of our waste-water treatment system be zero pollution of the receiving water supply?

Should communities and industry be required to continually upgrade water treatment facilities as allowed by new technological advances?

Who should pay for the upgrading of water supplies?

Should the quantity of water used by an individual be regulated through legislative or economic means?

Science:

There are several areas in the sciences where water quality issues can be studied, both individually and as a class.

Biology:

Biology 10/20/30: Student projects

Biology 10/20: Field studies in gathering on-site data related to quality of life forms at various points in a river (see accompanying story)

Biology 20: Environmental Biology — could investigate the impact of man on the quality of water

Biology 30: Focussing on the pressures of population growth on water demand and the ensuing problems on water quality.

Chemistry:

Chemistry 10: Chemicals in the environment — water contaminants

Chemistry 20: Environmental Chemistry — chemical aspects of water pollution

Chemistry 30: Locally developed unit on chemicals entering local water supply

Jim Martin is the head of Alberta Environment's environmental education resources branch.

If undelivered, return to:

Environment Views
Alberta Environment
9820 - 106 Street
Edmonton, Alberta T5K 2J6

Environment Update

Agricultural Land Hearings

The Environment Council of Alberta, in preparation for a series of hearings on agricultural land use, has released a 24-page background paper called *Maintaining and Expanding the Agricultural Land Base in Alberta.* The paper was prepared by researcher Peggy Thompson and is based on a series of reports and summaries discussing in detail many of the issues expected to be raised during the hearings.

The ECA also has a 28-minute film, "Tomorrow's Bread" available for loan. The publications (including the latest paper) and the film are available free from the ECA. Phone 427-5792 Edmonton; Zenith 06075 outside Edmonton.

The hearings are scheduled to begin October 12 in Calgary, with 16 locations on the panel's itinerary. A special public hearing held July 28 in Fort Vermillion was well-attended, ECA officials report.

Presenting Environmental Evidence

The Banff School of Management will offer a workshop **Oct. 30-Nov. 3** on **Presenting Environmental Evidence** for professionals, to teach and demonstrate ways of preparing and presenting evidence before regulatory tribunals, commissions of enquiry and courts. For more information, call Susie Washington, program manager, 762-6137.

Prairie Wildflowers

The result of a three-year study on the restoration and cultivation potential of Alberta's short grass prairie wildflower species has been published in a new book by the Devonian Botanic Garden. Called *Prairie Wildflowers: An illustrated manual of species suitable for cultivation and grassland restoration,* the book is written by R. Currah, A. Smreciu and M. Van Dyk and illustrated by J. Maywood. It is 290 pages, indexed.

The manual is available for $14.95 (mailing costs included). Checks should be made payable to the Friends of the Devonian Botanic Garden and mailed c/o NP Account to:

The Devonian Botanic Garden,
Room B-414 Biological Sciences Centre,
University of Alberta,
Edmonton T6G 2E9

Aquatic Toxicity Workshop

The 10th Annual Aquatic Toxicity Workshop will be held in Halifax November 7-10, 1983. It is one of a continuing series of annual workshops on aquatic and environmental toxicology in Canada, covering topics from basic research to applications in environmental monitoring, setting of regulations and guidelines and forming water quality criteria. The emphasis is on an informal exchange of ideas and information on the topic among all interested persons from industry, government, universities and consulting firms.

For further information, contact
R.F. Addison/P.G. Wells
Marine Ecology Laboratory
Bedford Institute of Oceanography
Dartmouth, N.S. B2Y 4A2
(902) 426-3279

Environmental Law

The Environment Law Centre and the John Janzen Nature Centre will again join forces to present a five-session evening course on environmental law to be held at the nature centre on alternate weeks beginning November 8. The course will provide an opportunity for the public to become acquainted with environmental law, legal actions and remedies, within the context of topical Alberta issues.

The Environmental Law Association has begun publishing a quarterly newsletter on environmental law issues in Alberta. Subscriptions will be $10/year. Further information on either the newsletter or the course is available from the centre at 411-10201 104 St., Edmonton T5J 1B2, or by calling 425-6740.

Impact Assessment Study

The results of a study of environmental impact assessment commissioned by the Institute for Resource and Environmental Studies, Dalhousie University, and the federal Environmental Review Office have been published. Entitled *An Ecological Framework for Environmental Impact Assessment in Canada,* this publication will be of interest to environmental biologists and others interested in impact assessment. Its authors are Gordon E. Beanlands and Peter N. Duinker. Copies are available free from the federal Environmental Assessment Review Office, 200 Sacre-Coeur Blvd., Hull, P.Q. K1A 0H3.

Environmental Biologists

Monthly meetings of the Canadian Society of Environmental Biologists will begin again in Edmonton in September. Location and dates were not available as this page went to press.

For information call John Lilley at 427-5792 or Lewis Cocks at 420-2600.

If you have a short news item of province-wide interest you'd like to contribute to Environment Update, please send it to the editor at the address on the Contents page. The editor reserves the right to select and edit the items.